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BY HAL CLEMENT

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CONTENTS

MAY, 1949 VOL. XLIII, NO. 3

SERIAL

NOVELETTES

SHORT STORIES

ARTICLE

READERS' DEPARTMENTS

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AST—1F

REACTOR RESEARCH

The Atomic Energy Commission has recently put out a brief explanation of some of the research work going on, and the experimental equipment needed to do that research. In particular, research into the nature and usefulness of different types of reactors—once called "atomic piles"—is of considerable interest in showing the state of the art as of now, and the reasons why the art is still an art, not a science.

Let's go back to the basics of uranium fission for a bit.

As most people, and practically all science-fictioneers know, the nucleus of Uranium isotope of atomic weight 235 is in a state of extreme tension. The introduction of a single extra neutron causes disruption, fission, and the release of several highly important items.

1. An enormous amount of energy.
2. Fission product nuclei—usually two for each fissioned U-235 atom, but as many as eight have been found occasionally from a single U-235.
3. Neutrons—on the average, the fission of *N* U-235 nuclei yields 2.3*N* new neutrons. That figure of 2.3 is a very rough guess; it's something over 2, and under 3.

A less well realized fact is that U-238 is *not* stable. U-238 atoms undergo natural, spontaneous fission themselves, even without being struck by neutrons. It's extremely rare, but the reaction is measurable. And, while a slow-moving neutron is simply absorbed by U-238, producing in succession U-239, then by radioactive decay Neptunium-239 and Plutonium-239, that is *not* the only reaction. U-238 fissions exactly the way U-235 does if it is hit by a *fast* neutron.

Let's put down, in tabular form, a very rough approximation of the reactions of various isotopes of the super-heavy elements to neutrons of various energies. First, Thorium-232 and Uranium-238 are very similar in their nuclear reactions, and can be classified together. U-238 can be converted to plutonium, and Thorium-232 —thorium's only naturally occurring isotope—can be converted to fissionable U-233. Both U-233 and plutonium react as does U-235. The way they react:

NEUTRON ENERGY in volts	Reaction of U-233, U-235 or Pu-239	Reaction of U-238 or Th-232
Over 1,000,000	Fissions	Fissions
100 to 1,000,000	Fissions	Low absorption to yield Pu-239 or U-233
50 to 100	Fissions	Moderate absorption
0.5 to 50	Fissions	High degree of neutron absorption
Below 0.5	Fissions	Low degree of absorption

The important general factors are that the so called "fissionable isotopes"—actually, they're all fissionable under the right conditions—are the ones that fission whenever a neutron of *any* energy, including the lowest, enters the nucleus. And they absorb neutrons of extremely low energy. U-238 nuclei will not absorb

a neutron of less than 1/20th of a volt energy; U-235 will. If a very occasional U-238 nucleus does accidentally absorb a 1/20th volt neutron, nothing much happens; if U-235 absorbs one, the result is catastrophic.

One of the most important concepts of modern nuclear physics is the "neutron absorption cross-section" of a nucleus. It's a bit difficult to get hold of the idea if you insist on a mechanical model of an atom. An atom is not subject to the same sort of laws that our macrocosmic machines are; it works on probability functions, not facts, so to speak. You've seen figures on the "diameter of the nucleus" or the "diameter of an atom." They don't mean a thing, unless it is also specified what measuring technique was used.

A mechanical analogy—guaranteed inaccurate, but indicative—may help. Suppose we want to measure the size of a barn, but we can't touch it. So we set up on one side of it a huge metal plate that will go *"Bong"* every time it's hit, and a machine gun on the other side. We start firing away, noting the angle of fire of the machine gun, and when we don't get *bongs*. Presently we have worked out the "shadow" of the barn, and then can determine its "diameter." The diameter turns out to be roughly eight feet. Remarkably small barn, isn't it? Becoming somewhat suspicious, we change from the 50-caliber machine-gun as a measuring instrument to a small rifle. Now we get an entirely different answer; there's still a solid structure about eight feet in diameter, but in addition there's a sort of skeletal structure about twenty-five feet in diameter. Finally, a third check is made using a toy air-rifle as the beam projector. Now the result is a solid object twenty-five feet in diameter.

For someone who can see, touch, and enter the barn to investigate, the answer is immediately evident. There's a tractor stored in the barn that's solid and massive enough to stop 50-caliber slugs, though the board walls and beams of the barn can't. The boards won't stop rifle bullets, either, though they will stop bee-bee's. The beams stopped the rifle bullets, so that a skeletal structure became evident on that test.

But—what is the diameter—the cross-section—of the barn? Well, now, that depends— It depends on what you're talking about. There's a further type of cross section we might determine for the barn, too. Suppose we start measuring its cross-section with the aid of a 105 mm rifle; this time we'll determine its "fission cross-section." The "fission cross-section" turns out to be about eight feet, too; the tractor's the only part of the structure that's solid enough to stop the heavy projectile long enough to make its delayed-action armor-piercing charge go off.

This analogy is, as stated, violently distorted—but it is indicative of the general proposition that the apparent size of a nucleus depends on the type of particle used in bombardment, and the velocity of that particle. In nuclei, however, much more complicated things go on. Have you ever dropped a small ball-bearing between the poles of a magnet? If it is dropped just right, it will fall through the gap between the poles completely undeflected. Slightly off absolute dead-center, it will fall through, but be twisted in its path to a greater or less degree. In nuclei, forces of that nature are at work, too.

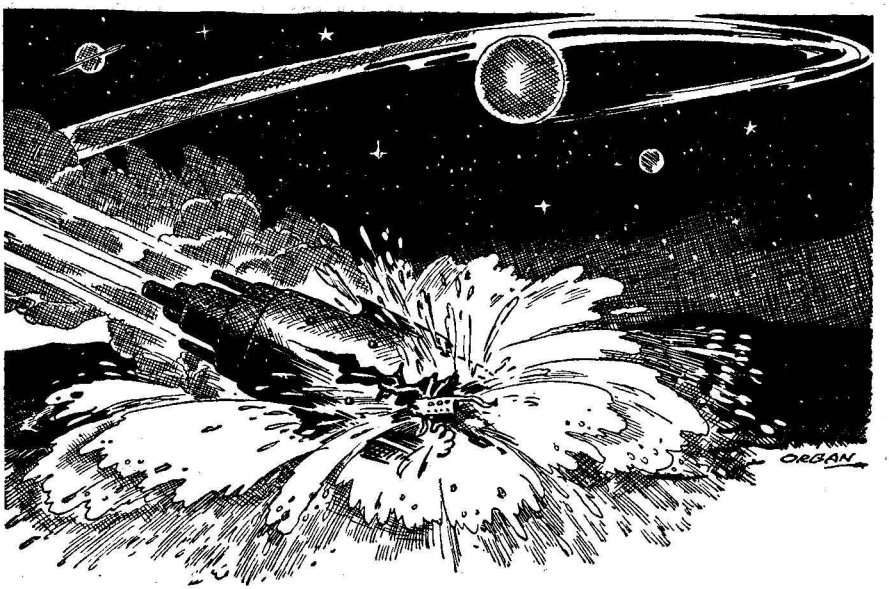
Finally, there's a resemblance to a rack of pool balls, representing the nuclear particles in the nucleus, being struck by the cue ball. Only our nuclear pool balls are magnetized, and tend to stick together. The cue ball can't be identified, either, once it arrives; the cue ball may strike, and the 8-ball go flying out. If our identification instrument can count but not identify balls, it will tell us that the cue ball went right through the whole mass without disturbing it.

So we have the concept of "neutron absorption cross-section," which is the most important single item in reactor design. For *very* slow neutrons—1/20th of a volt, say—the neutron absorption cross section of U-238 and Th-232 is small; that of U-233, U-235 or Pu-239 large, and the latter three fission on absorbing the neutron. At about two volts, the absorption cross section of U-238 is large, at ten volt neutron energies it's small again. At twenty-five volts, U-238 absorbs neutrons heavily again—has a large absorption cross-section—and again at about one thousand volts it has a large cross section. At very high voltages—in the millions range—U-238, Th-232, U-235, U-233, and Pu-239 all have relatively small neutron absorption cross-sections. But *all of these nuclei fission under those conditions.* Also, in the multi-megavolt range, elements down to and including lead and bismuth will fission.

U-235 is the only naturally occurring isotope which will fission with slow neutrons, thus producing fast neutrons to keep the atomic fire going. U-233 and Pu-239 can be synthesized and will display the same characteristic. But, since U-238 outnumbers U-235 in natural uranium 140 to 1, the first nuclear reactors were designed to trick those odds—stack the cards—in favor of U-235 by slowing the neutrons escaping to very low speeds. The neutrons emitted by fission are high-speed neutrons; they can, if absorbed immediately, fission either U-235 or U-238. Since both isotopes have a low absorption cross-section for fast neutrons, however, the neutrons usually escape from the small slugs used in the piles, into the moderator material. The moderator slows them down through the critical speeds—one thousand volts, twenty-five volts, and two volts—at which U-238 can grab them. Below two volts, the U-235 will, and U-238 won't absorb them, so despite the 140-to-1 odds of abundance, U-235 gets most of them. So much is past history; the new work has to do with two totally different types of piles.

First, when those two-plus neutrons are released in a fission, to keep this reaction running at constant level, one neutron must be used in another U-235 nucleus to cause another fission. The other one-plus is available for other uses. U-238 will not fission under ordinary conditions; it cannot be used to start an atomic reaction, and could fission theoretically only in the type of unmanageably violent reaction used in the atomic bomb. And there, U-235 would be necessary to get started. But if one neutron is added to U-238 it becomes Pu-239, and that is a useful atomic fuel. The ideal set-up then, would be a nuclear reactor using a mixture of U-235 and U-238 such that that spare neutron from the U-235 fission was absorbed by U-238, generating Pu-239. This way, as the U-235 was consumed, it would be re-

(*Continued on page 160*)



NEEDLE

BY HAL CLEMENT

***First** of two parts. A detective always has a tough job; the criminal is a needle in a haystack of people. But this detective of an alien world had a terrible task indeed; his needle could become a wisp of hay in a haystack!*

Illustrated by Orban

The Hunter suddenly realized that the ship ahead of him had become visible without the aid of instruments, and the vague alarm that had been nibbling at the outskirts of his mind rocketed into the foreground. He had been unable to understand why the fugitive should go below the speed of light at all, except in the hope that the pursuer would overrun him sufficiently to be beyond detection range; and when that failed, the Hunter had fully expected a renewed burst of speed.

Instead, the other ship had con-

tinued to decelerate. It had kept dead between the Hunter's machine and one of the planets of the system through which they were passing, so it was dangerous to overhaul it too rapidly; the Hunter had thought that preparation was being made for a break back to the Allane or Tordel systems; and he had not realized how close they both were to the looming planet until the appearance of the fugitive's hull as a spark of red against the blackness of the great world below showed he had actually entered its atmosphere.

That was enough for the Hunter. He flung every erg his converters could produce into a drive straight away from the planet, at the same time pouring the rest of his mass into the control room as a gelatinous cushion to protect his *perit* from the savage deceleration; and saw instantly that it would not be sufficient. He had just time to wonder that the creature ahead of him should be willing to risk its ship and host in what would certainly be a nasty crash, before the outer fringes of the world's gaseous envelope added their resistance to his flight and set his outer hull glowing a brilliant orange.

The ships had dived straight down the shadow cone; they were plunging to the night side. With an effort, the Hunter kept an eye on the instruments that revealed the other vessel's whereabouts; and it was well he did so, for the glowing cylinder abruptly vanished from sight into an enormous mass of water vapor that veiled the dark surface below them. A split second later, the Hunter's ship plunged into the same mass; and as it did so there was a twisting lurch, and the right-line deceleration changed to a sickening spinning motion. The pilot knew that one of the drive plates had gone, probably cracked off by undistributed heat; but there was simply no time to do a thing about it. The other vessel, he noted, had stopped as though running into a brick wall; now it was settling again slowly; and he himself could be only split seconds from the same obstacle, assuming it was horizontal.

It was. The Hunter's ship, still spinning wildly, though he had shut off the drive plates at the last moment, struck almost flat on water, and at the impact split from end to end along both sides, as though it has been an eggshell stepped on by a giant. Almost all its kinetic energy was absorbed in that blow; but it did not stop altogether. It continued to settle, comparatively gently now, and the half-conscious Hunter felt it bring its shattered hull to a gentle rest on what he realized must be the bottom of a body of water, a few seconds later.

At least, he told himself as his wits began slowly to clear, his quarry must be in the same predicament. The abrupt stoppage and subsequent slow descent of the other machine was now explained—even if it struck head on instead of horizontally, there would have been no perceptible difference in the result.

It was almost certainly unusable, even though not quite so badly damaged as the Hunter's.

That idea brought the train of thought back to his own predicament. He felt cautiously around him, and found he was no longer entirely in the control room—in fact, there was no longer room for all of him inside it. What had been a cylindrical chamber some twenty inches in diameter and two feet in length was now simply the space between two badly dented sheets of inch-thick metal, which had been the hull. The seams had parted on either side—or rather, seams had been made and forced apart; the hull was originally a single piece of metal worked into tubular shape—and the top and bottom thus formed had been flattened out and were now scarcely more than an inch apart, on the average. The bulkheads at either end of the room had crumpled like tissue. The *perit* was very dead—not only crushed by the collapsing walls, but the hydrostatic shock transmitted through the Hunter's semifluid body, in which it has been suspended for protection, had ruptured most of its more delicate organs. The Hunter, realizing this slowly, withdrew from around and within the little creature. He did not attempt to eject its mangled remains from the ship; it might be necessary to use it as food later on, though the idea was unpleasant. The Hunter's attitude toward the little animal resembled that of a man toward his dog.

He extended his explorations a little, reaching out with slender pseudopod through the rents in the hull. He already knew that the wreck was lying in salt water, but he had no idea of the depth other than that it was not excessive. On his home planet, he could have judged it quite accurately from the pressure; but he had not obtained a reading of this world's surface gravity before the crash.

It was dark outside the hull. When he constructed an eye from his own tissues—those of the *perit* had been ruptured—it told him absolutely nothing of his surroundings. Suddenly, however, he realized that the pressure around him was not constant; it was increasing and decreasing by rather marked increments, with something like regularity; and the water was transmitting to his sensitive flesh those other pressure waves which he interpreted as sound. Listening intently, he finally decided he must be fairly close to the surface of a body of water large enough to develop waves a good many feet in height, and that a storm of considerable violence was in progress. That he had failed to notice any storm during his catastrophic descent meant nothing whatever.

Poking into the mud around the wreck with other pseudopods, he found to his relief that the planet was not lifeless—he was already pretty sure of that fact, since there

was enough oxygen dissolved in the water to satisfy his needs, provided he did not exert himself greatly; there must consequently be free oxygen in the atmosphere above. It was just as well, however, to have confirmation; and he was well satisfied to locate in the mud a number of small, bivalve mollusks which upon trial proved quite edible.

Realizing that it was night on this part of the planet, he decided to postpone further outside investigation until there was more light, and turned his attention to the remains of his ship. He had not expected to find anything encouraging as a result of the examination, but he got a certain glum feeling of accomplishment as he realized the completeness of the destruction. Solid metal parts in the engine room had changed shape under the forces to which they had been subjected. The nearly solid conversion chamber of the main drive unit was flattened and twisted. There was no trace remaining of certain quartz-shelled gas tubes; they had evidently been pulverized and washed away by the water. No living creature handicapped by a definite shape and solid parts could have come through the crash alive, no matter how well protected. That thought was some comfort to him; he had done his best for the *perit* even though that had not been sufficient.

With these facts determined, the Hunter felt that he had done all that was possible for the time being. No really active work could be undertaken until he reached open air; and the lack of light was also a severe handicap. He relaxed, therefore, within the questionable shelter of the ruined hull, and waited for the storm to end and the day to come. With light and calm water, he felt that he could probably reach shore without assistance; the wave noise suggested breakers, which implied a beach at no great distance.

He lay there for several hours. The darkness remained unbroken, and it occurred to him once that he might be on a planet whose rotation matched its revolution; but the presence of liquid water made that most unlikely, as he quickly realized. It was probable that storm clouds were shutting out the daylight.

Ever since the ship had first settled into the mud, it had remained motionless. The terrific disturbance overhead was reflected in currents and backwashes along the bottom which the Hunter could feel, but which were quite unable to shift the half-buried mass of metal. With this conclusion reached long since, the castaway was suddenly startled when his shelter quivered as though to a heavy blow, and changed position slightly.

Instantly he sent out an inquiring tentacle. He formed an eye at its tip, but the darkness was still intense, and he returned to a strictly tactile exploration. Vibrations suggestive of a very rough skin scraping along the hull were coming to him; and abruptly something living ran

into the extended limb. It demonstrated its sentient quality by promptly seizing the appendage in a mouth that seemed amazingly well furnished with saw-edged teeth.

The Hunter allowed the portion of himself in direct contact with those unpleasant edges to relax into a semiliquid condition; and at the same time he sent more of his body flowing into the arm toward the strange creature. He was a being of quick decisions, and the evident size of the intruder had impelled him to a somewhat risky activity. He left his wrecked spaceship entirely, and sent his whole four pounds of jelly-like flesh toward what he hoped was a more useful conveyance.

The shark—it was an eight-foot hammerhead—may have been surprised, but in common with all its tribe it lacked the brains to be afraid. Its ugly jaws snapped hungrily at what had at first been satisfyingly solid flesh, only to feel it give way before them like so much water. The Hunter made no attempt to avoid the teeth, since he was immune to mechanical damage of that nature, but he strenuously resisted the efforts of the fish to swallow that portion of his mass already within its mouth; he had no intention of exposing his flesh to gastric juices.

As the shark's activities grew more and more frantically vicious, he sent exploratory pseudopods over the ugly, rough-skinned form, and within a few moments discovered the five gill slits on each side of the creature's neck. That was enough. His actions were no longer directed by a spirit of inquiry; he knew, with a precision born of long experience, what to do.

He was a metazoan—a many-celled creature—in spite of his apparent lack of structure, but the individual cells of his body were far smaller than those of most life forms: they compared in size with the larger protein molecules. Consequently, he could put forth and control a pseudopod fine enough to enter the very capillaries of a more orthodox organism without interfering seriously with its blood circulation. He had, therefore, no difficulty in insinuating himself into the shark's relatively huge body.

He avoided nerves and blood vessels as much as possible, and poured himself into such muscular and visceral interstices as he could locate. The shark calmed down at once, after the thing in its mouth and on its body ceased causing tactile messages to reach its minute brain; its memory was to all intents and purposes nonexistent. For the Hunter, however, successful interstition was only the beginning of a period of intense activity.

First and most important, oxygen. There was enough of the precious element absorbed on the surfaces of his body cells for only a few minutes of life at most. But it could always be obtained; in the body of a creature that also consumed oxygen; and the Hunter

rapidly sent submicroscopic appendages between the cells that formed the walls of blood vessels, and began robbing the oxygen-bearing cells of their precious load. He needed but little, and on his home world he had lived for years within the body of an intelligent oxygen-breather, as did most of his kind, with the other's full knowledge and consent. He had more than paid for his keep.

The second need was vision. His host presumably possessed eyes; and with his oxygen supply assured the Hunter began to search for them. He could, of course, have sent enough of his own material through the shark's skin to construct an organ of vision, but he might not be able to avoid disturbing the creature by such an act. Ready-made lenses were to be preferred; so he began seeking them.

He was interrupted very quickly. The crash had taken place, as he had deduced, rather close to land; the encounter with the shark had occurred in relatively shallow water, and had taken only a short time. Sharks are not fond of disturbance; it is hard to understand why this one had been so close to the surf. During the monster's struggle with the Hunter, it had drifted or been carried still closer to the beach; and with its attention no longer taken up by the intruder, it turned all its energies toward getting into deep water. This the Hunter did not know, having no sensory contact with the outer world. But once the shark began to exert itself, *after* the Hunter's establishment of an oxygen-theft system, things began to happen. The breathing system of a fish operates under a disadvantage, since the oxygen in the water is never at a very high concentration; and a water-breathing creature never has much oxygen to spare. Little as the Hunter was taking, it was enough to cut down the shark's physical powers markedly; at the same time, its blood-oxygen content decreased, and the Hunter almost unconsciously increased his drain on the system. It was a vicious circle that could have but one ending.

The Hunter realized what was happening before the shark actually died, but he could not cut down his own use of the precious gas any further. He could have left the shark, of course, but that would have left him almost completely helpless and adrift in the sea. Also, he had long since realized perfectly the shark's position on the evolutionary scale, and felt no particular compunction in sacrificing a savage carnivore to his own needs. The fact that the creature's efforts were probably being made against the waves, and that these were almost certainly carrying him where he wanted most to go, influenced his decision.

The shark took a long time actually to die, though it became helpless very quickly. Once it had ceased to struggle, the Hunter continued the search for its eyes, and eventually found them. He deposited a film of himself around and

between their retinal cells, in anticipation of the time when there would be enough light for him to see by, and then let nature take its course.

The breakers were sounding much more loudly by this time, and he realized that the assumption that he was drifting shoreward had been justified. The shark was drifting toward the surface as well, and a sickening up-and-down motion became perceptible as it entered the sphere of influence of the waves. Once or twice it actually broke the surface, and the Hunter, who had oxygen-seeking appendages already extended from the great fish's gill openings, profited thereby.

The rolling, tossing, and pounding suffered by the shark when its body finally entered the breakers was of such a nature that the Hunter was a little surprised at the small amount of resultant damage. Even he did not fully appreciate the enormous toughness of that semi-vertebrate structure. At last, after many minutes of forward-and-back motion in the shallows, they grounded; and though the backwash of the waves strove to drag the great body back to the sea, it was never quite successful. After a long time, the number of waves breaking over them began gradually to decrease, and the Hunter suspected that the storm was diminishing in intensity. In actuality, the tide had turned; but the result was the same.

By the time the combination of approaching dawn and thinning storm clouds provided enough light for the Hunter to see a little of his surroundings, his late host was thoroughly stranded, several yards above the reach of the heaviest waves, and well entangled in a mass of seaweed. The shark's eyes refused to focus on their own retinas out of the water, but the Hunter found a focal surface within the eyeball and built a retina of his own on it. He was also forced to modify certain imperfections in the lenses with more of his own body substance; but at last he was able to see about him with satisfactory clarity, yet without exposing himself.

There were rifts in the storm clouds now, through which a few of the brighter stars were visible against the gray background of approaching dawn. Slowly these breaks grew larger, and by the time the sun appeared above the horizon the sky was almost clear, though the wind still blew fiercely.

His vantage point was not ideal, but he was able to make out a good deal of his surroundings. In one direction the beach extended a short distance to a line of tall, slender trees, crowned by feathery tufts of leaves. He could not see beyond these, his vantage point being too low, though they were not themselves thickly enough set to obstruct the view. In the opposite direction was more debris-strewn beach, with the roar of the surf sounding beyond it. The Hunter could not actually see the ocean, but its direc-

tion was obvious. To the right as one looked at the trees was a body of water; and for a moment the Hunter was a trifle surprised, for it showed no sign of the huge waves that were still pounding behind him. Then he realized it must be a small pool, filled by the storm, but now emptying back into the sea so that the large waves could not enter. This, he realized, was probably the reason he had stranded so easily; his shark had been washed into this pool, and left behind by its diminishing waters.

Several times he heard raucous screeching sounds and saw birds overhead. This pleased him greatly; evidently there were higher forms of life than fishes on the planet, and there was some hope of obtaining a more suitable host. An intelligent one would be best, since it would ordinarily be best able to protect itself and him and was also likely to travel more widely, thus facilitating the now necessary search for the pilot of the other ship; but he realized that there might be some difficulty in obtaining access to the body of an intelligent being who was not accustomed to the idea of symbiosis.

All that, however, would have to wait on chance. Even if there were intelligent beings on the planet, they might never come to this spot. It would be best to wait, several days if need be, to find out just what forms of life frequented the locality; and then make plans to invade the one that seemed best suited to his purposes. Time was probably not vital; it was as certain as anything could be that his quarry was no more able to leave the planet than was the Hunter himself, and while he remained on it the search would be long and arduous. Time spent in careful preparation would undoubtedly pay dividends.

He waited, therefore, while the sun rose higher in the sky and the wind gradually died down to a mild breeze. It became quite warm; and a growing awareness of chemical change going on around him caused him to realize that, if a sense of smell were common equipment among the life forms of this world, he was certain to have visitors before long. He could have halted the process of decay by the simple expedient of consuming the bacteria causing it; but he had no objection to company.

His first visitors were gulls. One by one they descended, attracted by sight or smell or both, and began tearing at the sheltering carcass. The Hunter withdrew himself to the lower portions of the body, and made no attempt to drive them away—even when they pounced on the eyes of the great fish and speedily deprived him of visual contact with the outside world. If other life forms came, he would know it anyway; and if they didn't, it was just as well to have the gulls there.

The greedy birds remained undisturbed until midafternoon. They did not make too much progress in disposing of the shark; the tough

skin defied their beaks in most places. They were persistent, however, and when they suddenly took wing and departed altogether it was evident to the Hunter that there must be something of interest in the neighborhood. He hastily extruded enough tissue from one of the gill slits to make an eye, and looked cautiously about him.

He saw why the gulls had left. From the direction of the trees a number of much larger creatures were approaching. They were bipeds, and the Hunter estimated, with easy skill, that the largest must weigh fully a hundred and twenty pounds—which meant that the addition of his own mass was unlikely to prove a serious burden. Much closer to him was a quadruped, running rapidly toward the dead shark and uttering an apparently endless string of sharp yelping sounds. The Hunter placed it at about fifty pounds, and reserved the information for future use, if it became necessary.

The four bipeds were running as well, but not nearly so rapidly. As they approached, the hidden watcher examined them carefully, and was greatly pleased at what he saw. They could travel with respectable speed; their skulls gave promise of considerable intelligence, if one could safely assume that they were the receptacles of brains; their skins were almost entirely unprotected, giving promise of relatively easy access through the pores. As they slowed up and stopped beside the hammerhead's body, another indication of intelligence appeared—they gave utterance to articulate sounds that could only represent speech. The Hunter was delighted; he had not dared hope for such an ideal host so quickly.

Of course, there were still problems to be solved. They were probably not used to symbiosis, for the Hunter was quite sure he had never encountered a member of this race before, and he was familiar with all those with whom his people normally associated. Therefore, is was almost certain that the idea would be repulsive to them, unless full explanations could be made before any other contact were attempted. They would almost certainly take it for granted that a mass of unfamiliar jelly trying to cling to one of them was an inimical creature. Subtlety would have to be employed.

The four bipeds remained looking down at the shark and conversing for only a few minutes; then they walked off up the beach a little distance. Somehow, the Hunter got a vague impression from their attitudes that they considered the neighborhood unpleasant. The quadruped remained a little longer, examining the carcass closely; but it apparently failed to notice the rather oddly placed eye that was following its movements with so much interest.

A call from the direction in which the others had gone finally attracted its attention, and as he watched it bound off, the Hunter saw with

some surprise that the others had entered the water and were swimming around with considerable facility. He marked down the fact as another point in their favor—he had seen no trace of gills, and as air breathers they must have had a considerable margin of oxygen-intake capacity above their minimal needs, to remain under water as long as he saw one of them do. Then he realized that there was another good point; he could probably approach them much more easily in the water. It was evident from their behavior that they could not see too clearly below the surface—they invariably raised their heads out of the water to orient themselves, and did this with considerable frequency. The quadruped was evidently no cause for worry; it kept its head and eyes above the surface at all times.

The thought led to instant action. A threadlike pseudopod groped rapidly toward the pool, an inch or two under the sand. The eye was kept in operation until most of the jellylike body had crossed the four-yard gap; then another was formed at the water's edge, and the Hunter drew the rest of his body into a compact mass just below it. The operation had taken several minutes; winding among sand-grains had been an annoyingly devious method of approach.

The water was quite clear, so it was not necessary to keep an eye above the surface to direct the stalk. The mass of jelly was quickly molded into an elongated, fishlike

shape with an eye in front, and the Hunter swam toward the boys with considerable speed. In one way, he reflected, it was really easier to see under water; he could use an air lens, held in place by a very thin film of flesh, and this was much more transparent. His own substance did not make a very satisfactory lens—it was too opaque.

He had planned to swim right up to one of the boys, hoping his approach would not be noticed and that the swirl of water, or possibly contact with one of the other boys, would mask his own efforts. Halfway there, however, he found what seemed a better way to approach unnoticed. It was a large jellyfish, bobbing along after the manner of its kind; and with his attention drawn to the creature, the Hunter suddenly realized that there were quite a number of them in the vicinity. Evidently the bipeds did not consider them dangerous, or they would not be swimming at this place.

Accordingly, he changed his form and method of locomotion to agree with those characteristics of the Medusae, and continued his approach. His color was slightly off, but he felt that this fact was less likely to attract notice than was a radically wrong shape. He may have been right, for he got almost up to one of the boys without exciting alarm. They were fairly close together at the moment, splashing and ducking each other, and he had high hopes of making contact —he did, in fact, with a cautiously extended tentacle, discover that the varicolored integument covering a portion of their bodies was an artificial fabric; but before he could do any more, the subject of his investigations slid to one side and moved several feet away. He gave no sign of alarm, however, and the Hunter at once resumed his approach. It ended in precisely the same fashion, except that this time he did not get quite so close.

He tried each of the other boys in turn, with the same annoying near-success. Then, puzzled by a phenomenon which seemed to be exceeding the generous limits of the laws of chance, he drifted a short distance away and watched, trying to learn the reason for it. Within five minutes he realized that, while the creatures apparently had no serious fear of jellyfish, they most sedulously avoided actual contact with them. He had chosen an unfortunate camouflage.

Robert Kinnaird avoided jellyfish almost without conscious thought. He had learned to swim at the age of five, and in that and each of the nine subsequent years of his life had had enough painful experience with the things to assure his avoiding their company. He had been fully occupied in ducking one of his companions when the Hunter had first touched him, and had dodged hastily when he saw the blob of jelly in the water beside him; but the only real emotion he felt on the

subject was relief at escaping contact with the stinging tentacles. He had forgotten the encounter immediately, but his attention had been sufficiently diffused by it to prevent the thing's again approaching so closely.

About the time the Hunter realized what was wrong, the boys grew tired of swimming, and retired to the beach. He watched them go in mounting annoyance, and continued to watch as they ran back and forth along the sand playing some obscure game. Were the mad creatures never still? How in the Galaxy could he ever come into contact with such externally active beings? He watched, and pondered.

Ashore, once the salt had dried on their sun-browned hides, the boys began to quiet down, and cast expectant glances toward the grove of coconut palms that hid the center of the island from their direct view. One of them seated himself, facing the ocean, and suddenly spoke.

"Bob, when are your folks coming with the grub?" Robert Kinnaird flung himself face downward in the sunlight before replying.

"'Bout four or half past, Mother said. Don't you ever think of anything but eating?" The other mumbled an inarticulate reply, and subsided flat on his back, gazing up into the cloudless blue sky. Another of the boys took up the conversational ball.

"It's tough, you having to go tomorrow," he said. "I kind of wish I was going with you, though. I haven't been in the States since my folks came out here. I was only a kid then," he added serenely.

"It's not so bad," returned Bob slowly. "There are a lot of good fellows at the school, and there's skating and skiing in the winter, that you don't get here. Anyway, I'll be back next summer."

The talk died down, and the boys basked in the hot sunshine as they waited for Mrs. Kinnaird and the eatables for the farewell picnic. Bob was closest to the water, lying stretched in the full sunshine—the others had sought the rather thin shade of the nearest palms. He was already well tanned, but wanted to get the last possible bit of benefit from the tropical sun, which he would miss for the next ten months. It was hot, and he had just spent an active half hour, and there was nothing to keep him awake—

The Hunter was still watching, eagerly now. Were the peripatetic things really settling down at last? It looked like it. The four bipeds were sprawled on the sand in various positions, which they presumably found comfortable; the other animal came as he watched and settled down beside one of them, letting its head rest on its forelegs. The conversation, which had been almost incessant up to this point, ceased; and the amorphous watcher decided to take a chance. He moved rapidly to the edge of the pool.

The nearest of the boys was nearly ten yards from the water.

It would not be possible to maintain a watch from the Hunter's present position, and at the same time send himself under the sand to a point below the motionless body; and he must keep his goal in sight. Once more camouflage seemed called for; and once more, the ever-present jellyfish seemed to fill the want. There were a number of them lying stranded on the sand, motionless; perhaps, if he moved slowly and emulated their shape, the Hunter could escape notice until he was close enough for an underground attack.

He may have been excessively cautious, since none of the creatures was facing his way and all were nearly if not entirely asleep; but caution is never wasted, and the Hunter never regretted the twenty minutes he took getting from the water's edge to a point three yards from Robert Kinnaird. That, judging by the previous experience, was close to enough.

Had anyone been watching the large jellyfish lying apparently helpless a few feet from the boy at that instant, he might have noticed a peculiar dimunition in its size. The shrinking itself was not remarkable; it is the inevitable fate of a jellyfish on a hot beach; but the more orthodox Medusae merely grow thinner until only a cobwebby skeleton remains, while this specimen dwindled not only in thickness but in diameter, and there were no remains whatever. Until it had almost completely gone, of course, there was an odd little lump or knot right in the center which preserved its size and shape while the body around it dwindled; but this at last went too, and no trace except a slight depression remained on the sand—a depression which, that careful observer might have noticed, extended all the way from the water's edge.

The Hunter kept the eye in use during most of the underground search. His questing appendage at last reached sand that was more closely compacted than usual and, advancing now very cautiously, finally encountered what could only be living flesh. Robert's toes had become rather deeply buried in the sand, as he was lying on his stomach; and the Hunter found that he could operate without emerging at all to the surface. With that fact established, he dissolved the eye, and drew the last of his mass out of sight below the sand—with considerable relief, as the unobstructed sunlight affected his unprotected tissues painfully.

He did not attempt to penetrate until his whole body was wrapped about the half-buried foot. He surrounded the limb with extreme care, and finally was in direct contact with the skin over an area of several square inches. Then he commenced interstition, letting the submicroscopic cells of his flesh slide through pores, between cells, under and around the toenails—into all the thousands of openings that lay unguarded in this, to his way of thinking, singularly coarse organism.

The boy was sound asleep, and remained so. The alien organism flowed smoothly along the bones and tendons in his foot and ankle; up within the muscle sheaths of calf and thigh; switched to the outer wall of the femoral artery and the tubelets within the structure of the thigh bones; around points, and along still other blood vessels. It filtered through the peritoneum without causing the least damage; and slowly the whole four pounds of matter accumulated in the abdominal cavity, not only without harming the boy in the least but without even disturbing his slumber. And there, for a few minutes, the Hunter rested.

Bob was aroused, like the other boys, by his mother's voice. She had come silently, laid a blanket in the shade, and spread the eatables on it before speaking; and her first words were the ancient, "Come and get it," which have stimulated boys and men to sometimes startling activity for a good many decades. She would not stay to help them eat it, though cordially and sincerely pressed to do so by the boys, with whom she was popular, but went back through the palm grove to the road that led to their home.

"Try to be back by sundown," she called to Bob over her shoulder as she reached the trees, "you still have to pack, and you'll have to be up early in the morning." Bob nodded, with his mouth full, and turned back to the food-laden blanket.

After disposing of that which lay before them, the boys sat and talked for the standard hour-after-eating; then they returned to the water, where they indulged further in games of violence; and at last, realizing that the abrupt tropical night would soon be upon them, they gathered up the blanket and started for the road and their respective dwellings. They were rather silent, with the awkwardness natural to their age when faced by a situation which adults would treat either emotionally or with studied casualness. The farewells, as they passed their respective dwellings, were brief, and accompanied by reiterated and reciprocated promises to "write as soon as you can."

Bob, proceeding at last alone to his own house, felt the customary mixture of regret and pleasurable anticipation which he had come to associate with these occasions. By the time he reached home, the latter feeling had gained the ascendance, and he was looking forward with considerable eagerness to meeting again the school friends he had not seen for over two months. He was whistling cheerfully as he entered the house.

The packing, done with the tactful assistance of his mother, was quickly completed, and by nine o'clock he was in bed and asleep. He himself considered the hour rather early, but he had learned the value of obedience at certain times very early in life.

All this time the Hunter had remained quiescent. Having entered from air rather than water, he had been able to bring quite a supply of oxygen with him; and it was some hours before he found it needful to draw on his host for more. He would have liked to remain inactive for an entire day, in order to learn more about the cycle of physiological processes which this organism undoubtedly performed differently from any other he had ever used; but that was not possible. Like any other life form, he used some energy in living, no matter how quietly; and at last he found it necessary to commence exploration.

For some time he had been aware that his host was asleep; but this in no way decreased his caution. He remained for the time being below the diaphragm, not wishing to disturb the heart which he could feel beating just above it, and quickly located a very large artery which offered no more resistance to his penetration than had any other part of the human organism thus far. He found to his intense satisfaction that he could draw sufficient oxygen for his needs from this vessel without seriously diminishing the total quantity that passed through it. He checked this very carefully; his whole attitude in the present exploration was utterly different from that which had characterized his actions within the shark; for he had already come to look upon Robert in the light of a permanent companion during his stay on the earth, and his actions were ruled by a law of his kind so ancient and so rigid as to assume almost the proportions of an instinct.

Do nothing that can harm your host. It was a law as binding as the Hippocratic oath or a marriage vow. To the majority of the Hunter's kind, even the desire to break it never existed, since they lived on terms of the warmest friendship with the intelligent metazoans who harbored their formless bodies; and the few individuals who proved to be exceptions to this rule were looked on by their fellows with the liveliest horror and detestation. It was such a being whom the Hunter had been pursuing at the time of his crash on Earth; and that being must still be found. to preserve a defenseless race from the inroads of the irresponsible creature.

Do nothing that can harm your host. From the instant of the Hunter's arrival, the swarming leucocytes in the boy's healthy blood had been up in arms. He had avoided the most serious contact with them up to now by avoiding the interiors of blood vessels, though there were enough of them wandering free in the lymphatics and connective tissue to be a nuisance. His body cells were not immune to their powers of absorption, and only by keeping any part exposed to their attack in constant evasive motion had he been able to avoid serious damage to himself. He knew that this could not go on indefinitely; for one thing, he must occasionally

direct his attention to other matters, and for another, the continuation of such a misunderstanding, whether he continued evasive action or began to fight back, would mean an increase in white blood cell concentration and most probably illness of some sort to the host. Therefore, the leucocytes must be pacified. His race had, of course, acquired a general technique for solving this problem long since; but care had to be taken in individual cases—particularly unfamiliar ones. By a trial-and-error process, carried out with as much speed as was practical, the Hunter determined the nature of the chemical clues by which the white cells differentiated invading organisms from legitimate members of the human body; and after prolonged and still extremely careful effort, he exposed every one of his own cells to sources of the appropriate chemicals in the blood stream. A few molecules of the desired substance were adsorbed on the surface of each of the cells, and this proved, to his relief, to be sufficient. The leucocytes ceased to bother him, and he could use the larger blood vessels safely as avenues of exploration for his questing pseudopodia.

Do nothing that can harm your host. He needed food as well as oxygen. There was not a single form of tissue around him which he could not have consumed with relish; but selection must obviously be practiced. There were certainly intruding organisms in this body—besides himself—and they were the natural food source; for by consuming them he would be eliminating their menace to his host, and thereby helping earn his keep. Identifying them would be easy; anything a leucocyte attacked was legitimate prey for him. It was improbable, of course, that this source of food would prove adequate for long, small as his needs were; it would soon be necessary to tap the alimentary canal as well. That, however, would be simple and would in no way harm the boy. His appetite might be increased very slightly over a long period, but a little additional chewing was no cause for alarm.

For many hours the cautious exploration and adjustment continued. The Hunter felt his host awaken and resume activity, but he made as yet no effort to look outside. He had one problem which must be carefully and accurately solved; and, although his avoiding thousands of leucocytes at once, as he had done for a time, may seem evidence to the contrary, his powers of attention were limited. Filaments of his mass, far finer than human neurons, gradually formed an all-inclusive network throughout Bob's body from head to toe; and through those threads the Hunter gradually came to know the purpose and customary uses of every muscle, gland, and sense organ in that body. Throughout this period most of his mass remained in the abdominal cavity; and it was fully seventy-two hours after his first intrusion that the alien felt secure enough in his

position to pay attention once more to outside affairs.

As he had done with the shark, he began to fill the spaces between the boy's retinal cells with his own body substance. He was actually able to make better use of the eyes than could Bob himself, for the human eye sees in maximum detail only the objects whose images fall within an area of retina scarcely a millimeter across; the Hunter could use the whole area on which the lens focused with reasonable sharpness, which was considerably greater. In consequence, he could examine objects with Bob's eyes at which the boy was not looking directly. This was a help, since many of the things in which the hidden searcher was most interested were too commonplace to the human being to attract more than momentary attention.

The Hunter could hear dimly even within the human body; but he found it helpful to establish physical contact with the bones of the middle ear. Thus, hearing as well and seeing better than his host, he felt ready to investigate the planet on which chance had marooned him and his quarry. He began to look and listen. There was no further reason for delay in prosecuting his mission to track down and destroy the other member of his race now free on the planet.

He had not, up to this moment, really appreciated the magnitude of the task. He had not considered particularly the fact that the other might be as well hidden as was he himself, that the planet represented an enormous search area however small it might be as planets went, and that even a very small population of possible hosts meant a most appalling amount of search work even if he could recognize the presence of the alien at sight—which he most certainly could not.

All these facts were brought to his attention with shocking suddenness as he took his first clear look around since meeting Robert Kinnaird. The picture that fell on their common retinas was that of the interior of a cylindrical object that vaguely suggested his own spaceship, filled with several rows of seats, most of them occupied by other human beings. Beside him was a window, through which Bob was looking at the moment; and the suspicion that had entered the Hunter's mind at sight of the vehicle was instantly confirmed by the view through that window. They were on board an aircraft, traveling at a considerable altitude with a speed and in a direction which the Hunter was in no position to guess. He had hoped at least to begin his search in a region of the crash of the two spaceships; now he realized he would be extremely fortunate even to find that region.

The flight lasted for several hours, and the Hunter quickly gave up the attempt to memorize landmarks over which they passed. One or two of them did stick in his mind, and might give a rough clue to direction

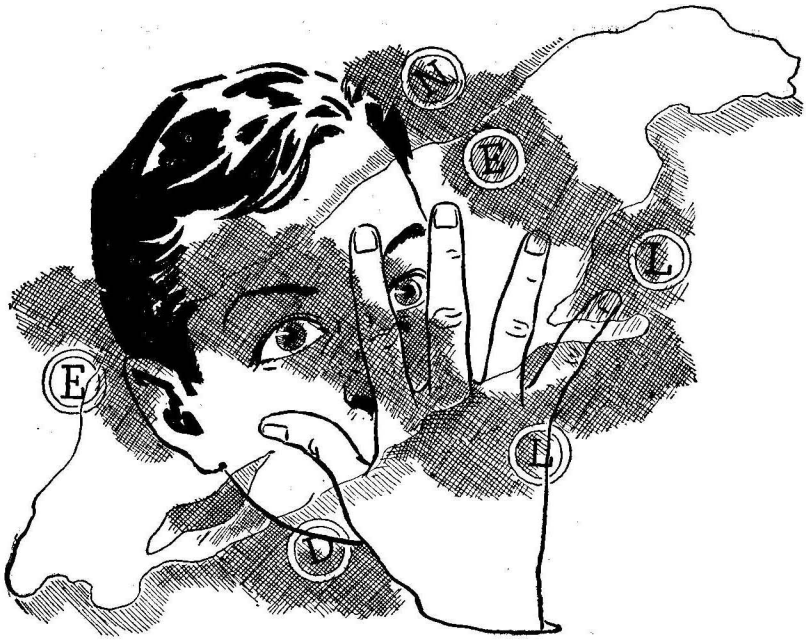
if he could ever identify them later; but he put little trust in this chance. He must keep track of time rather than position, and when he was more familiar with human ways, find out where his host had been at the time of his own intrusion.

The view was interesting, however. It was a beautiful planet, even from his alien viewpoint; mountains and plains, rivers and lakes, forests and prairies were all visible at various times, now clearly through a crystal atmosphere and now in glimpses between billowing clouds of water vapor. The machine he rode occupied some of his attention, as well; from Robert's window he could see a portion of a metal wing, bearing at least one attachment which evidently contained an engine, as a rapidly rotating airfoil was visible ahead of it. By symmetry, there must be at least two and possibly four of these engines, the Hunter realized; and the machine, as a whole, suggested a very considerable degree of mechanical advancement on the part of this race. If this were the case, it might be worth while to attempt direct communication with the individual serving as his host. That, however, must await further developments.

Eventually the machine began to descend gradually. The Hunter could not see directly ahead, and it happened that they entered a solid cloud layer almost immediately, so he was unable to get any idea of their destination until just before the landing; but at that moment, as they broke out of the lower fringe of clouds, they made a broad turn over a large seaport city. The Hunter saw a great harbor, with docks and shipping galore, and buildings that reached as far as he could see; then the faint drone of the engines that penetrated the airplane's cabin increased in pitch, a huge wheel appeared below the visible nacelle, and the big machine glided downwards to contact with a faint jar a broad, hard-surfaced runway located on a point of land across the harbor from the city's largest buildings.

As Robert disembarked, he glanced back at the airplane; so the Hunter was able to form a better estimate of its size and construction details. He had no idea of the power developed by the four huge engines, and consequently could form no estimate of the machine's speed; but he could see the quivering above the nacelles that told of hot metal within, and realized that at least they were not the phoenix converters most familiar to his own civilization. Whatever they were, it had already become evident that the craft could put a very respectable fraction of the planet's circumference behind it without descending for fuel.

After alighting from the airplane, the boy entered a large building nearby, which was crowded with other human beings, and waited for a time. Presently he made his way through the throng to a broad coun-



ter, and received his baggage, which be bore off to the other end of the building where a number of ground vehicles were standing. He boarded one of these, which remained where it was until nearly full of passengers, and then moved off toward the denser portion of the city.

During the next several hours, the boy's actions were largely meaningless to his hidden guest. He changed buses several times, wandered about the city on foot for a while with no apparent purpose, and attended a movie. Fortunately the Hunter's vision persistence involved a time lapse of approximately the same duration as the human retina, so he also saw moving pictures rather than discrete projections. It was still daylight when they left the theater, and the Hunter decided that it must have been fairly early in the morning when he had first established visual connection with the outside world.

Now his host was walking with what seemed to be a purpose. They returned to a building where they had been earlier, where Robert once more collected his bags; then, after the ticket-window preliminaries which the Hunter was beginning to recognize as customary before a ride, they boarded still another bus. This was decidedly the longest single ride they had taken since leaving the airplane; they were well outside

the city, having passed through several smaller collections of buildings, and the sun was almost down when the bus left them at the roadside.

A smaller road led off up a gentle slope; and at the top of this slope was a large, sprawling building—or group of buildings; the Hunter was not sure which. Robert Kinnaird picked up his bags and walked up the hill toward the structure, and the alien began to hope that the journey had ended for the time being at least. He was right, as it turned out.

To Robert, the return to school, assignment to a room, and meeting with old acquaintances was by now a familiar story; but to the Hunter every activity and everything seen and heard was of absorbing interest. He realized that most of it could have no direct application to his mission, but that was no reason to ignore possible sources of knowledge. He was a being of omnivorous interests, and was beginning to realize that direct communication with the human race was going to be necessary. That meant understanding them and their customs, preparatory to learning their spoken and written languages.

So he looked and listened almost feverishly, as Bob went to his room, unpacked, and then wandered about the school meeting friends from former terms. Most particularly he sought to connect spoken words with their meanings; and at first he had a good deal of trouble, for the conversations were mostly about events of the past two months vacation, so that the words usually lacked visible referents. He did learn a few personal names this first evening, among them that of his host, and decided that he could acquire an understanding of the spoken language with little loss of time.

He spent Robert's sleeping hours in organizing the few words he had learned, and developing a definitely planned campaign for learning more as rapidly as possible. It may seem odd that one who was so completely unable to control his own goings and comings should dream of planning anything; but the extra effective width of his vision angle must be remembered. He was to some extent able to determine what he saw, and therefore felt that he should decide what to look for.

It would have been so much simpler if he could control his host's movements in some way, or interpret or influence the multitudinous reactions that went on in his nervous system. He had controlled the *perit,* of course, but not directly; the little creature had been trained to respond to twinges given mechanically to the appropriate muscles, as a horse learns to respond to the reins. The Hunter's kind used the *perits* to perform actions which their own semiliquid bodies lacked the physical strength to do; and which were too delicate for their intelligent hosts to perform—or which must be per-

not reach, such as the interior of the tiny racer that had brought the Hunter to Earth.

But Robert Kinnaird was not a *perit,* and could not be treated as one. It was necessary to appeal to his mind, not his body. The Hunter had come to about the best possible place for that purpose, though he did not yet know it.

Classes began the next day. Their purpose was at once obvious to the unlisted pupil, though the subjects were frequently obscure. Kinnaird's courses included, among other subjects, English, physics, Latin, and French; and of these four, physics proved most helpful to the Hunter in learning the English language. After witnessing a demonstrated experiment in elementary mechanics and comparing it with the explanatory diagrams produced on the board by the instructor, he was able to interpret most of the diagrams in Bob's textbook—he had learned the relatively few and simple drawing conventions. Slowly, helped by other experiments performed either by the instructor or Bob himself, many of the printed words became intelligible. Unfortunately for the Hunter's needs, Bob was a sufficiently advanced reader to have long outgrown subvocalization, so it was some time before the Hunter could determine the relationship between written and spoken words; but one day a heavily-lettered diagram was explained vocally by the teacher, and a few days the Hunter was able to picture the written form of any new word he heard—allowing, of course, for the spelling irregularities which are a curse of the English tongue. By the beginning of November, two months after the opening of the school, the alien's vocabulary had about the size though not the content of an intelligent ten-year-old's. He had a rather excessive store of scientific terms, and many blanks where less specialized words should have been. Also, the meaning he attached to such words as "work" was the purely physical one—not the more inclusive meaning conveyed to the mind of the average layman. He thought it meant "force times distance" and only that.

By this time, however, he had reached a point where tenth-grade English had some meaning to him; and Robert's literature assignments began to be of some help—new words were frequently intelligible from context, ignorant as the Hunter was of human customs.

About the beginning of December, a slight interruption occurred to the unregistered pupil's education. Robert Kinnaird had been a member of the school's football team during the fall. The Hunter, with his intense interest in the health of his host, somewhat disapproved of this, though he understood the need of any muscled animal for exercise. The final game of the school season was played on Thanksgiving Day, and when the Hunter realized it *was*

the final game, no one gave more thanks than he.

But he rejoiced too soon. Bob, reconstructing one of the more exciting moments of the game to prove his point in an argument, slipped in some very greasy mud and twisted an ankle severely enough to put him in bed for several days. The Hunter was not annoyed so much at the enforced absence from classes, since the boy did a certain amount of reading even in the infirmary, but at his own failure to prevent the accident. Had he realized the danger even two or three seconds in advance, he could have supplied considerable reinforcement to the tendons throughout the body; but once the sprain had occurred, he could do practically nothing to speed up its healing—the danger of infection was already nil without his help.

The incident at least recalled him to some of the duties of a symbiote. From then on, the web of alien cells surrounding Bob's bones and muscle sheaths was ready at an instant's notice to tighten to the limits of the Hunter's physical power. This was not very great, but it helped salve the intruder's conscience.

Back in class, host and symbiote both worked harder than usual to make up for lost time. By now, the Hunter felt quite at home in the English language, understanding both what he heard and read with very satisfactory proficiency.

Though vastly interested in this task for its own sake, he had never forgotten his primary mission. He had learned quite early that he was in a school, and deduced from this that his host was not an adult; he knew the names of the city, state, and even the country in which the school was located; and he had never ceased from striving to learn the name and location relative to his present position of the place where the boy had spent his last vacation. He wasted no time in vituperating the luck which had led him to select as host probably the only individual in a large group who was going to leave the neighborhood of the crash so soon and travel so far; it was a misfortune, he would readily have admitted, but there was no point in worrying about what was past.

He did learn, from a chance remark passed between Bob and one of his friends, that the place was an island. That would be some help, anyway; even though the fugitive was most probably no longer there, he or rather the being he took as host must have used a vehicle of some sort for his departure; the Hunter remembered his attempt to use the shark too vividly to suppose that the other could escape in a fish, and he had never heard of a warm-blooded air breather that lived in the water. Seals and whales had never come up in Bob's conversation, at least not since the Hunter had been able to understand it.

If a vehicle had been used, it could probably be traced—more easily than a free organism, at any

rate. The Hunter was thankful for small blessings.

It remained to learn the location of the island. Bob received frequent letters from his parents; but for some time these did not strike the Hunter as clues, partly because he had a good deal of trouble reading script and partly because he did not know the relationship to the boy of the senders of the letters. He had no scruples about reading Bob's mail, of course; he simply found it difficult. Robert did write to his parents, at somewhat irregular intervals; but he had other correspondents as well, and it was not until nearly the end of January that the Hunter found that by far the greater number of his letters were going to and coming from one particular address.

This discovery was eased by the boy's receipt of a typewriter as a Christmas present; this greatly facilitated the Hunter's reading of the outgoing mail, and he quickly learned that the letters went to Mr. and Mrs. Arthur Kinnaird. He knew from his reading of the custom of family names descending from father to son; and the deduction seemed defensible that the boy would spend his vacation with his parents. If this were true, he had the name of the island. It was now simply a question of locating it—and getting there as soon as possible. He realized that Robert would probably be going back for his next vacation, but that would give the fugitive five more months to cover his tracks; and he had had five already. To anyone but the Hunter, the search would already have seemed utterly hopeless.

There was a large globular map of the planet in the school library, and almost a plethora of flat maps and charts on walls and in the various books in the school. Robert's persistent failure to bestow more than a passing glance at any of them quickly grew maddening; and the Hunter began to be tempted to try forcing his eyes. It was a bad idea, and no one knew it better than he; but he possessed emotions as powerful as those of any human being, and experienced fully as much difficulty at times in keeping them in check.

He controlled himself, however—partially. He successfully resisted the temptation to tamper with Robert's sclerotic muscles; but gradually there welled up within his being a growing conviction that direct communication with his host must be attempted if any further progress were to be made on his mission. The idea had, of course, been in the back of his mind from the time he had first entered the boy's body. At that time he had hoped the necessity would not present itself, for a number of grave problems were involved; but now he felt convinced that there was no alternative. He might ride Robert Kinnaird's body for the rest of the human being's life—which, with the hidden visitor, would probably be long—without ever approaching a place where clues

to the whereabouts of his quarry could be obtained. *With* the active and intelligent assistance of the host, however; with his knowledge of Earth and its people combined with the Hunter's familiarity with the ways of his own kind; with an able and healthy body willing to assist the alien instead of bearing him willy-nilly over the face of the globe —there could be no comparison of the relative chances. Communication was essential; and now, the means was at hand.

With the beings who normally served as hosts to the Hunter's kind, conversation eventually reached a high level of speed and comprehensiveness. It must be remembered that the union took place with the host's full knowledge and consent; and therefore almost anything the symbiote did to affect the former's sense organs could be, and was interpreted as a means of communication. It was immeasurably more complex than vocal speech; twinges at any and all muscles, shadow-images built directly on the retina of an eye, motions of the fur with which the Allanese were thickly covered—for the most part, the meaning of any of the "signs" was self-evident; and after a few years' companionship, conversation was almost telepathic in lucidity and speed between host and indweller.

Even with this background lacking for the second party, however, the Hunter felt that he could make himself known to and understood by his human host. Though the latter had no inkling of his existence, and would probably have suffered a severe emotional shock had the fact been proven to him, the Hunter suddenly realized the circumstance had played into his hands.

There was the protective net he had constructed over Bob's muscles; and there was the typewriter. The net could be contracted, like the muscles it covered—though with far less power. If a time were chosen when Bob was sitting at the typewriter without particular plans of his own, it might be possible for the Hunter to strike a few keys in his own interest. The chances were really not too good; they depended upon Bob's reaction when he found his fingers acting without orders.

Two nights after the Hunter had made his decision to act, the opportunity occurred. It was a Saturday evening, and the school had won a hockey game that afternoon. This proved a sufficient stimulus to cause Bob to write to his parents. He went to his room—the other occupant was not in at the time—got out the typewriter, and pounded off a description of the day's events with very fair speed and accuracy. At no time did he relax sufficiently to make an opportunity for control, in the Hunter's opinion; but with the letter finished and sealed, Robert suddenly remembered a composition which his English teacher had decreed should be turned in the following Monday. It was as foreign to his nature as to that of most other

schoolboys to work so far in advance; but the typewriter was out, and the hockey game offered itself as a subject which he could treat with some enthusiasm. He inserted a fresh piece of paper in the machine, rapidly typed the standard heading of title, pupil's name, and date; then he paused to think. He had just written about this subject, but the readers of the first composition would be somewhat less critical of form, spelling and grammar than would his English teacher. A little care must be exercised.

The Hunter neither knew nor cared what Robert was planning to write. The fact that blazed itself on the amorphous tissue that in some obscure fashion acted as his brain was that they were sitting in front of a typewriter containing a blank piece of paper, with fingers resting on the keyboard and every muscle controlling those ten digits completely relaxed. The alien wasted no time whatever. He had long since decided on the wording of the first message. Its first letter lay directly under the boy's left middle finger; and the net of alien flesh about the appropriate muscle promptly tugged as hard as it could on the tendon controlling that finger.

The finger bent downward obediently, and contacted the desired key, which with equal complaisance descended—halfway. The tug was not powerful enough to lift the type bar from its felt rest. The Hunter had not realized that he was so weak, compared with human muscle; Bob's manipulation of the typewriter had seemed so completely effortless. He sent more of his flesh flowing into the net which was trying to do the work of a small muscle, and tried again—and again and again. The result was the same. The key descended far enough to take up the slack in its linkage and stopped.

All this, of course, had attracted Bob's attention. He had, of course, experienced before the quivering of muscles abruptly released from a heavy load; but there had been no load here. He pulled the offending hand away from the keyboard, and the suddenly frantic Hunter promptly transferred his attention to the other. As with a human being, his control, poor enough in the beginning, grew worse with haste and strain; and the fingers of Robert's right hand twitched in a most unnerving fashion. The boy stared at them, terrified. He was more or less hardened to the prospect of physical injury, as anyone who plays football and hockey must be, but there was something about nervous disorder that undermined his morale. It is a horrible jolt for a person still young enough never to have doubted seriously his own physical and mental powers suddenly to be given cause to question his own sanity; and even if Bob did not go quite that far, the inability to stop his fingers from quivering was nearly as unpleasant. It gave him

a completely unaccustomed helpless feeling.

He clenched his fists tightly. The quivering stopped, to his relief—the Hunter knew he could never overcome muscles opposed to his own attempts. When the fists were cautiously relaxed, after a few moments, the alien made another try—this time on arm and chest muscles, in an effort to bring the hands back to the typewriter. Bob, with a gasp of dismay, leaped to his feet, knocking his chair back against his roommate's bed. The Hunter was able to deposit a much heavier net of his flesh about these larger muscles, and the unwilled tug had been quite perceptible to the boy. He stood motionless, now badly frightened, and tried to decide between two courses of action.

There was, of course, a stringent rule that all injuries and illnesses must be reported promptly to the school infirmary. Had Bob suffered damage such as a cut or bruise, or even had a headache or stomach disorder, he would have had no hesitation in complying with this order; but somehow the idea of owning to a nervous complaint seemed rather shameful, and the thought of reporting his trouble grew more repugnant every moment. As might be expected, he finally decided to put it off, in the hope that matters would be improved by morning.

He put the typewriter away, took out a book, and settled down to read. At first he felt decidedly uneasy; but as the minutes passed without further misbehavior on the part of his muscular system, he gradually calmed down and became more absorbed in the reading matter. The increasing peace of mind was not, however, shared by his unsuspected companion.

The Hunter had relaxed in disgust as soon as the writing machine had been put away; but he had no intention of giving up. The fact that he *could* impress himself on the boy's awareness without doing him physical damage had been something gained; even though interference with his muscles produced such a marked disturbance, there were other methods which suggested themselves to the alien. Perhaps they would prove less disconcerting, and he knew they could be equally effective as means of communication. The Hunter was no psychologist, and had never actually faced the problem now before him—though he had read a few purely theoretical books dealing with it. The symbiosis now so common between his race and the Allanese had started in a small way before the written history of the latter people; there had always been, as far back as the records went, someone of the prospective host's own species to explain and persuade solitary beings to take up the relationship; and with the beginning of interworld travel, there had always been the means for similar preparation of new races.

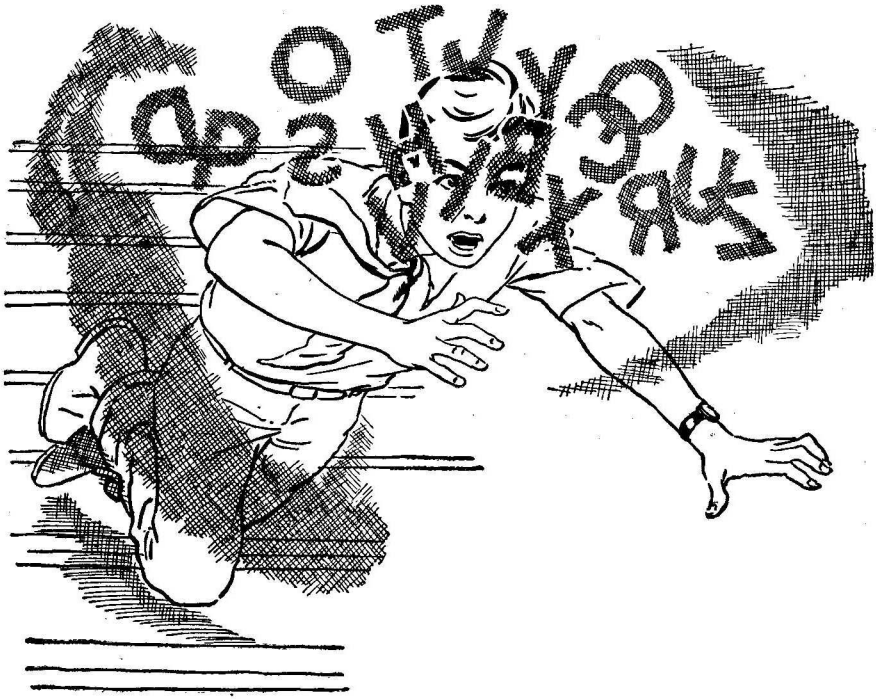
It was not too surprising, therefore, that the Hunter did not blame

the disturbance he had created so much on the mere fact that there had been interference as on the particular method he had used, and felt no misgivings as to the effect on his host's mind of further attempts. He did just the worst thing he could possibly have done; he waited until his host appeared to be over the shock of the first attempt, and promptly tried again.

This time he worked on Bob's vocal cords. They were similar in structure to those of the Allanese, and the Hunter could alter their tension mechanically just as he had pulled at the muscles of the limbs. He did not, of course, expect to form words; that requires control of diaphragm, tongue, jaw, and lips as well as vocal chords, and the symbiote was perfectly aware of the fact; but if he exerted his influence when the host was exhaling, he could at least produce sound. He was trusting to a frequency method —repeating numbers and their squares by means of interrupted sounds; precisely the method which many human beings have advocated should occasion ever arise for demonstrating the existence of intelligence on this planet.

He got farther than any human being, knowing the facts, would have expected, principally because Kinnaird was just finishing a yawn as the interruption started and was not able to control his own breathing right away. The Hunter was busily engaged in producing a series of four rather sickly croaks, having completed two and paused, when the boy caught his breath and an expression of undiluted terror spread over his face. He tried to let out his breath slowly and carefully; but the Hunter, completely absorbed in his work, continued the unnerving operation regardless of the fact that he had been interrupted. It took him some seconds to realize that the emotional disturbance of his host had reappeared in full force.

His own emotional control must have relaxed to some extent at this realization. No other means of explaining the thing he did next makes any sense whatever. Recognizing clearly that he had failed again, knowing perfectly that his host was almost frantic with an emotion that robbed him of most of his control, the alien nevertheless not only failed to desist from his attempts but started still another form of "communication." Perhaps he felt that he had gone too far to retreat; perhaps he had recognized the damage done by the pause between the first two attempts and was determined not to repeat the error; whatever his excuse may be, he was certainly not using the common sense he normally displayed. His third attempt involved cutting off light from his host's retina in patterns according to letters of the English alphabet—regardless of the fact that by this time Robert Kinnaird was rushing down the hallway outside his room, bound for the dispensary,



and the Hunter knew perfectly well that there lay ahead a rather poorly lighted stairway.

The inevitable results of interference with his host's eyesight under such circumstances did not impress themselves upon the Hunter's mind until Bob actually missed a step and lunged forward, grasping futilely for the rail.

It must be said for the alien that he recovered his sense of duty rapidly enough. Before the hurtling body touched a single obstacle he had tightened around every joint and tendon with his utmost strength; and it is quite possible that Robert was saved a severe sprain thereby. One thing certainly was done most efficiently; as the sharp, upturned corner of one of the metal cleats which held the rubber treads on the stairs opened the boy's arm from wrist to elbow, the alien was on the job so fast that the blood which escaped was not sufficient to flow away from the immediate neighborhood of the wound. Bob felt the pain, looked at the injury which was being held closed under an almost invisible film of unhuman flesh, and actually thought it was a scratch that had barely penetrated the skin. He turned the corner of the cleat down with his heel, and proceeded to the dispensary at a more moderate pace.

He was calmer when he got there, for the Hunter had been sobered into discontinuing his attempts to make himself known.

The school did not have a resident doctor, but did keep a nurse on constant duty at the dispensary. She could make little of Robert's description of his nervous troubles—the fact is by no means to her discredit—and advised him to return the next day at the hour one of the local doctors normally visited the school. She did examine the cut on his arm, however.

"It's clotted over, now," she told the boy. "You should have come here with it sooner—though I probably wouldn't have done much to it."

"It happened less than five minutes ago," was the answer. "I fell on the stairs coming down to see you about the other business—I couldn't have brought it to you any faster. If it's already closed, though, I guess it doesn't matter."

Miss Rand raised her eyebrows a trifle. She had been a school nurse for fifteen years, and was pretty sure she had encountered all the more common tales of malingerers. What puzzled her now was that there seemed no reason for the boy to prevaricate; she decided, rather against her will, that he was probably telling the truth.

Of course, some people's blood *does* clot with unusual speed, she remembered. She examined Robert's forearm again, more closely. Yes, the clot was extremely fresh; the shiny, dark red of newly congealed blood. She brushed it lightly with a fingertip—and felt, not the dry, smooth surface she had expected, or even the faint stickiness of nearly-dry blood, but a definite and unpleasant *sliminess.*

The Hunter was not a mind reader and had not foreseen such a move. Even if he had, he could not have withdrawn his flesh from the surface of Robert's skin; it would be hours, more probably a day or two, before the edges of that gash could be trusted to hold themselves together under normal usage of the arm. He had to stay, whether he betrayed himself or not.

He watched through his host's eyes with some uneasiness as Miss Rand drew her hand away sharply, and leaned over to look still more closely at the injured arm. This time she saw the transparent, almost invisible film that covered the cut, and leaped to a perfectly natural but completely erroneous conclusion. She decided that the injury was not as fresh as Robert had claimed, that he had "treated" it himself with the first substance that he had found handy—possibly airplane dope or something of that order—and had not wanted the fact to come out.

She was doing the boy's common sense a serious injustice, but she had no means of knowing that. She was wise enough to make no accusations, however, and without saying anything more took a small bottle

of alcohol, moistened a swab with it, and started to clean away the foreign material.

Had the Hunter been in control of a set of vocal chords, he would probably have been unable to suppress a howl of anguish. He possessed no true skin, and the body cells overlaying the cut on his host's arm were completely unprotected from the dehydrating action of the fluid on the swab. Direct sunlight had been bad enough. Alcohol felt to him about the same as concentrated sulphuric acid feels to a human being—and for the same reason. Those outer cells were killed almost instantly, desiccated to a brownish powder that could have been blown away, and would undoubtedly have interested the nurse greatly had she had a chance to examine it.

There was no time for that, however. In the shock of the sudden pain, the Hunter relaxed all of the "muscular" control he was exerting in that region to keep the wound closed, and the nurse found herself confronted with a long, clean slash some eight inches from end to end and half an inch deep in the middle, which suddenly started to bleed very enthusiastically. She was almost as startled as Robert, but her training showed its value; she had compresses applied and bandaged in place in very creditable time, though she was rather surprised at the ease with which she managed to stop the bleeding. Then she reached for the telephone.

Robert Kinnaird was rather late in getting to bed that night. He was tired, but had trouble getting to sleep; the local anaesthetic the doctor had used while he was sewing up the arm was starting to wear off, and he was becoming progressively more aware of the member as time went on. He had almost forgotten the original purpose of his visit to the dispensary in the subsequent excitement; and now, separated by a reasonable time from the initial fright, he was able to view the matter more clearly. He thought about it now, staring into the darkness of his room.

The Hunter had also had time to alter his viewpoint. He had left the arm completely when the anaesthetic was injected, and busied himself entirely with his problem. He now realized that the disturbance of *any* natural function or sense organ was likely to upset his host's emotional control seriously, and he was beginning to have a rather accurate suspicion of the effect that realization of his own presence where he was would probably have. Nothing originating in his own body would be interpreted by a human host as an attempt at communication; the idea of a symbiosis of intelligent life forms was completely foreign to the race. The Hunter berated himself for not realizing this much earlier.

He had some excuse, of course. He had been blinded to any idea save that of communication from within by at least two factors; lifelong

habit, and a reluctance to leave his host. Even now he found himself trying to produce a plan which would not involve his departure from Robert's body. He had known from the beginning what his chance of return would be if the boy saw him coming; and the thought of being barred from the home to which he had become so well adjusted, of sneaking about as an almost helpless lump of jelly in an alien and unfriendly world, seeking host after host as he worked his way stepwise back toward the island where he had landed, seeking unaided for traces of a fugitive almost certainly as well hidden as he himself was at the moment—he put the pictures firmly out of his mind.

Yet communicate he must; and he had demonstrated to his own satisfaction the futility of trying it from within. Therefore, he must—what? How could he get into intelligent contact with Robert Kinnaird, or any other human being, from outside? He could not talk; he had no vocal apparatus, and even his control over his shape would be overstrained by an attempt to construct a replica of the human speech equipment from lung to lip. He could write, if the pencil were not too heavy; but what chance would he get? What human being, seeing a four-pound lump of jelly trying to handle writing materials, would stand still and wait for legible results? The Hunter had come to appreciate rather completely the homocentric viewpoint of his host's species, though his last assumption may have done some of them an injustice.

Yet there was a way. Every danger he had considered was a conditional one: he could not get back into Bob's body *if* the boy saw him coming; no human being would take his own senses seriously *if* he saw the Hunter writing; no human being would believe a message written by the Hunter that that person had not actually seen written —*if* the Hunter could not furnish substantial evidence of his own existence. Although the last two difficulties seemed to possess mutually exclusive solutions, the puzzled alien suddenly perceived an answer.

He could leave Bob's body while the boy slept, compose a written message, and return before he awakened. No one would see him in the darkness; and as for the authenticity of the note—Robert Kinnaird, of all human beings on the planet, was the one who would have to take seriously such a message. To him alone, as things were at the moment, was the Hunter in a position to prove not only his existence but his whereabouts. There was another advantage to the plan; Robert's realization that the alien was actually within his body would not have the same emotional impact, since he would not actually see the other.

The idea seemed good, though admittedly risky. The Hunter had never been overly reluctant to take chances, however, and quickly decided that the plan contained his only hope. With a course of action

firmly in mind, he once more began to pay attention to his surroundings.

He could still see; the boy had his eyes open, must still be awake. That meant delay, and more strain on his patience. It was annoying, this night of all nights, that Bob took so long to go to sleep—annoying, even though the Hunter could guess the cause, and hold himself at least partly responsible. It was nearly midnight, and the Hunter was having trouble holding his temper in check, by the time respiration and heart beat gave definite proof that his host was sound asleep, and he dared begin his planned actions. He left as he had entered, through the pores of the skin of one of Bob's feet—experience had taught him that this part of his host's body was least likely to be moved abruptly during sleep, and such motion would have made it very difficult for the Hunter to avoid causing some resistance which might have awakened the boy. The maneuver was accomplished successfully, however, and without delay the alien flowed downward through sheet and mattress and reached the floor under the bed.

Although the window was open and the shade up, it was too dark to permit him to see well; there was no moon, and no bright light at all close to the building. He could, however, make out the outlines of the study table shared by the room's two inmates, and on that table there were, he knew, always writing materials. He moved toward it, in a smooth, amoeboid flow, and a few moments later was among the books and papers that littered the table top.

Clean paper was easy to find; a scratch pad was lying by itself at the edge of the table in front of one of the chairs. There were pencils and pens as well; but after a few minutes of experimentation, the Hunter found them too unmanageable—partly because of their weight, but mostly because of their length. He quickly found a remedy, however; one of the pencils was a cheap variety of the mechanical type, and he was able to work the lead out of it after a few minutes of prying. He found himself with a thin, easily manageable stick of the usual clay-graphite writing compound, soft enough to make a visible mark even under the relatively feeble pressure the Hunter could apply.

Armed with this, he set to work on the scratch pad. He printed slowly but neatly; the fact that he could barely see what he was doing made no difference, since he had disposed his body so as to cover the paper and could "feel" quite adequately the precise position of each letter. He had spent considerable time planning just what the note was to say, but would have been the first to admit that it might not be too convincing. However, the die was cast; he had started, and would certainly gain nothing by quitting at this point.

"Bob," the note began—the Hunter did not yet fully realize that certain occasions call for more formal means of address—"these words apologize for the disturbance I caused you last night. I must speak to you; the twitching of muscles and catching of your voice were my attempts. I have not space here to tell who and where I am; but I can always hear you speak. If you are willing for me to try again, just say so. I will use the method you request; I can, if you relax, work your muscles as I did last night, or if you will look steadily at some fairly evenly illuminated object I can make shadow pictures in your own eyes. I will do anything else within my power to prove my words to you; but you must make the suggestions for such proofs. This is terribly important to both of us. Please let me try again."

The Hunter wanted to sign the note, but could think of no way to do so. He had no personal name; in the minds of both intelligent races of Allane he was simply the companion of Jenver the Second-of-Police; and he wisely judged that to use such a title in the present instance would detract from the chances of Bob's believing a single word of the note. He left the message unsigned, therefore, and turned his attention to the problem of where to leave it. He did not want Bob's roommate to see it, at least until after his host had done so; therefore, it seemed best to carry the paper to Bob's bed and place it on, or even under, the covers.

This the Hunter proceeded to do, after he managed to work the sheet on which he had been writing free of the block to which it had been attached. Getting a better idea on the way across the room, he left it in one of Robert's shoes, and returned successfully to the interior of the boy's body, where he proceeded to relax and wait for morning. He did not have to sleep in that environment—Bob's circulatory system was amply capable of taking care of the visitor's metabolic wastes as fast as they were formed. For the first time the Hunter found himself regretting this fact; he had used little more than an hour in the preparation and placing of his message, and an eternity seemed to pass before the dark rectangle of the window—which he could not watch—lightened with the approach of dawn and the "reveille" buzzer sounded in the corridor outside. The mere fact that no classes met on Sunday was not considered an excuse for remaining in bed.

Robert Kinnaird had little idea how closely his motions were being followed as he slowly opened his eyes and sat up. Remembering that it was his turn, he sprang barefooted across the floor, slammed down the window, and leaped back to the bed where, more leisurely, he began to dress. His roommate, who had enjoyed his privilege of remaining under the covers until the

window was closed, also emerged and began groping for articles of clothing. He was not looking at Robert, and the other had his back to him anyway; so he did not see the momentary expression of surprise that flickered across Kinnaird's face as he saw the sheet of paper which had been loosely rolled up and thrust into one of his shoes.

He pulled out the note, scanned it quickly, thrust it into a pocket, and continued donning his shoes. His instantaneous thought, of course, was that someone—probably his roommate—was up to some sort of trick; so he concealed all outward sign of surprise after the first moment, and said nothing. Many people would have destroyed the paper at once, publicly, to make obvious their proof against gullibility; Bob seldom did anything so final in haste. He nearly drove the Hunter mad by acting as though he had not seen the note until mid-morning; but he had not forgotten it.

He had simply been waiting until he was alone, and could count on being so for a while. In his room, with the other occupant safely in the recreation room playing off a chess final, he took out the note and read it again carefully. His initial opinion remained unchanged for a moment; then a question occurred to him. Who could have known about his troubles the night before?

Of course, he had told the nurse; but he could not imagine either her or the doctor indulging in practical jokes of this nature—nor would they have told anyone who might. There might be other explanations—probably were; but the easiest one to check at the moment was that which took the note at face value. He looked outside the door, in the closet, and under the beds, to make sure he was unobserved—after all, there are many adults who consider it a disgrace to "fall" for a practical joke—then seated himself on one of the beds, looked at the blank wall opposite the window, and said aloud, "All right, let's see your shadow pictures."

The Hunter obliged.

There is a peculiar pleasure in producing cataclysmic results with negligible effort; ask the foreman of a blasting crew or the pilot of a heavy aircraft. The Hunter felt it now; his only work was in thickening by a fraction of a millimeter some of the semitransparent body material already surrounding the rods and cones in his host's eyeball so as to cover those sensitive nerve endings and exclude some of the incident light in a definite pattern. Accustomed as he was to the maneuver, it was completely effortless; but it produced results of a very satisfying magnitude. Bob started to his feet, staring; he blinked momentarily, but persistence of vision carried the rather foggy word "thanks" which had apparently been projected on the wall until he opened them again. The word tended to "crawl" a bit as he watched it—not all of the letters were on the

fovea, and when he turned his eyes to see them better, of course they went with it. He was reminded of the color spots he sometimes saw in the dark, on which he never could turn his eyes properly.

"Wh- who are you? And where are you? And how—?" his voice died out as questions flooded into his mind faster than he could utter them.

"Sit quietly and watch, and I will try to explain." The words flowed across his field of vision. The Hunter had used this method before, with the written language of Allane, and in a very few minutes had attained Bob's normal reading speed. He tried to hold it there, since if he changed letters either more or less rapidly, the boy's eyes started to wander.

"As I said in my note, it is hard to explain who I am. My job corresponds to that of one of your police agents. I have no name in the sense that you people have, so you had best think of me as the Detective, or the Hunter. I am not a native of this planet, but came here in pursuit of a criminal of my own species. I am still seeking him; both his ship and mine were wrecked when we arrived, but circumstances carried me away from our point of landing before I could begin an orderly search. That fugitive represents a serious menace to your people, and for that reason I ask your help in locating him."

"But where do you come from? What sort of person are you? And how do you make these pictures before my eyes?"

"All in good time." The Hunter's limited reading in English had made him rather fond of clichés. "We come from a planet of a star which I could point out to you, but whose name I do not know in your language. That is not important at the moment." The Hunter changed his mind about that statement the instant after he made it. "I am not a person like yourself. I fear you do not know enough biology to permit a good explanation; but perhaps you know the difference between a protozoan and a virus. Just as the nucleated cells which make up your body evolved from the large, protozoan-type creatures, so did my body evolve from the far smaller cells you call viruses. You have read about such things, or I would not know your words for them; but perhaps you do not remember."

"I think I do," replied Bob aloud. "But I thought viruses were supposed to be practically liquid."

"At that size, the distinction is slight. As a matter of fact, my body has no definite shape—you would think of an amoeba if you were to see me. Also I am very small by your standards—yet my body consists of thousands of times as many cells as yours."

"Why not let me see you? Where are you, anyway?"

The Hunter dodged the question. Instead of answering it directly, he explained about the symbiotic man-

ner in which his kind normally passed their existence; explained the reasons for it, the limitations inherent in his flimsy physical structure, and the value of the joint life to both species. For one not well versed in human psychology, he did a good job; quite early in the explanation the boy had inferred that the other was already living symbiotically in some earth creature, and was giving the explanation as proof of his existence when Bob should see his host. The youngster was even starting to envy the metazoan race of Allane which had the good fortune to have such efficient guardians against disease and injury. Luck played a hand in the Hunter's timing; it was just as he started to admit his actual whereabouts that Bob remembered the incident in the nurse's office the preceding evening.

To the Hunter's relief, the boy was more interested than shocked. At his request the symbiote repeated the attempts at muscle control that had caused so much disturbance fifteen hours before; but he refused to show himself, wisely guessing at the probable results. He was too relieved by the present state of affairs to want to take any chances with it.

Actually, he had made an incredibly lucky choice of hosts. A much younger child could not have understood the situation and might have been frightened out of its senses; an adult would most probably have headed at top speed for the nearest psychiatrist's office. Bob was old enough to understand at least some of the Hunter's tale, and young enough not to blame the whole thing on subjective phenomena.

At any rate, he listened—or rather, watched—steadily and soberly as the Hunter unfolded the series of events which had brought him first to Earth and then halfway around it, to a Massachusetts boarding school. The alien explained clearly the problem which lay before him, and the reason why Bob should interest himself in it. The boy understood clearly enough; he could easily envision the mischief of which his guest would be capable in his present location, if he did not possess a moral sense, and the thought of a similar entity loose among the human race, uninhibited by any such restriction, made him shudder.

The really troublesome phase of the problem struck him before the Hunter got around to mentioning it.

"I say, Hunter," he asked suddenly "how do you plan to find this fugitive? How can you recognize his presence?" The alien did not answer immediately.

"Frankly, I am not sure. I have been working entirely on the problem of getting back to the island where I landed, and taking up the trail from there. I planned to worry about means of tracing when I got there. I do not deny it will be difficult; even under normal circumstances one cannot tell by sight whether one of my people is present

in a body at which one is looking, and now there is not only the time that has been lost by my mischance, but the fact that the person harboring the fugitive may actually be ignorant of the fact—as you were until now."

"Are you certain that he will take refuge in a human body? Is no other kind suitable?" asked Bob.

"Any creature large enough to stand the drain on its system will serve. I should think, however, that he would seek a human host, for the same reasons that I did; an intelligent being is ordinarily the safest in any given environment, and human beings move more freely than any others about this planet, except for birds. I have not come across any bird in my reading since I landed here large enough to make a satisfactory host. Also, the assumption that the fugitive has joined with a human being at least gives us something definite to start on. It may be mental cowardice on my part, of course; but the prospect of searching a few thousand human beings and following their movements for the past few months seems a lot more practical than doing the same for a numberless legion of other life forms. If I don't restrict the problem to something practical, I won't have the courage to undertake it at all."

"I see what you mean, all right," said Bob. "You do have the needle-in-the-haystack situation with a vengeance." The Hunter was familiar with the expression.

"That describes it well—except for the fact that the needle is camouflaged as a wisp of hay," was his answering comment.

They were interrupted at this point by Bob's roommate, returning to prepare for dinner, and there was no further chance for conversation that day. Bob saw the doctor about the arm during the afternoon; and, since the Hunter possessed no mir-

aculous healing powers, the doctor considered its progress normal. It was pleasantly free of all signs of infection. "In spite," the doctor remarked, "of that silly trick of yours. What did you try to close it with, anyway?"

"I did nothing to it," replied the boy. "It happened when I was on my way to the dispensary anyway, and I thought it was just a scratch myself until the nurse started cleaning it and everything let go." He saw the doctor did not believe him, and decided there was little use pursuing the argument. He had been doubting the reality of the whole experience himself, until the doctor had brought up the arm phenomenon without prompting. It was another bit of evidence in favor of the Hunter's existence, had Bob been still disposed to doubt it, but it would be a waste of time, he felt, to tell the doctor that. The feeling of superiority engendered by his knowing something the doctor didn't prevented his resenting to any great extent the other's doubt of his veracity. Nothing had been said between him and his guest about keeping the latter's presence a secret, but it had occurred to the boy that if knowledge of the alien spread too far it might affect the chances of success in the search rather seriously; so he let the doctor finish his lecture without further objection, and left as soon as he could.

Shortly after the evening meal he found another opportunity to get off by himself, and at once put a question to the Hunter.

"What do you plan to do about getting back to the island? Normally, I won't be going until the middle of June, nearly five months from now. Your fugitive has already had about that length of time to get under cover—or out of the way. Do you plan to wait, or have you thought of some means of getting there sooner?"

"My motions, from now on, are wholly dependent on yours," responded the Hunter. "To leave you now would be to waste all the work of the last five months, except the knowledge I have gained of your language and customs. You are the only human being on whom I can count for understanding help; there is no telling how long it would take to become familiar and on such good terms with another of your race. At the same time, it is true that the sooner I get back to that island, the better it will be. I know you are not completely free to control your own actions, but if you could devise some means of getting us back there soon it would be a great help. I can be of little help in such matters; you have grown up in this environment, and can judge more accurately the chances of a plan of action. The situation is the usual one on my home world—matters requiring physical action are almost entirely the responsibility of the host. All I am qualified to do in the present situation is furnish advice about the probable actions of our quarry, and

what to do when we find him. What valid reason could you offer your people for returning at once to the island?"

Bob did not answer at once. The idea of taking such a matter into his own hands was rather new to him; but, inevitably, it grew more attractive as he thought about it. Of course, he would miss a lot of school—but that could be made up later. Quite plainly, if the Hunter were telling the truth, this matter was more important; and Robert could see no reason at that time why his guest should prevaricate. He was face to face, in consequence, with the problem of getting home at once.

Simply disappearing was not to be thought of. Apart from the purely practical difficulties of crossing the continent and a good part of the Pacific without assistance, he had no desire to cause his parents anxiety if it could be avoided. That meant that a *good* excuse for the journey must be found, so that it could be undertaken with official approval. The Hunter was right; Bob must find or invent that excuse, himself.

The more he thought about it, the clearer it seemed that only physical illness or injury would serve. Homesickness had been known to produce results in one or two cases, but, remembering what he had thought of the individuals in question, Robert discarded that idea—he did not want that reputation. It would be nice to acquire an injury in some manner which would reflect credit on himself—through a heroic rescue or some similar adventure; but he had sense enough to realize that opportunity was small and the actual merit of the idea nil. Of course, the hockey season was still on; anything might happen of its own accord.

As for illness, that could not very well be acquired at will. He could perhaps imitate something well enough to fool friends and teachers; but he did not deceive himself for an instant into thinking he could fool a doctor for any length of time. Faking was out, therefore. The usual run of ideas—false telegrams requesting his presence, pretense of bad news from home, and all their variations ran through his mind, for he had read his share of the more melodramatic literature; but none of them satisfied the objections which his sound common sense at once brought forward. He found himself in a complete quandary, and told the Hunter so after many minutes of concentration.

"This is the first time I have regretted choosing such a young host," answered that being. "You lack the freedom of travel that would be granted an adult. However, I am sure you have not exhausted your fund of ideas. Continue to think, and let me know if I can help in any of your plans." That terminated the conversation for the time, and Bob left his room in search of amusement.

Presently he was enjoying a game of ping-pong with one of his classmates in the recreation room adjacent to the gym; but his subconscious mind must have been working on the problem, for in the middle of the first game he had another idea—as luck would have it, at a time when to go through with it if the Hunter nor watch for his answers. He had been doing quite well at the game up to this point, but after the idea struck him he became so preoccupied with it that the contest resulted in his ignominious defeat. He had to pull himself together with an effort, realizing that it would be some time before he could secure the Hunter's comment on the plan, in order to give enough of his attention to the business in hand to make a respectable showing.

It was indeed quite a time before he had another talk with his invisible guest. When he returned to his room, the other occupant was already there; and his presence prevented conversation not only until "lights out" but throughout the night, as Bob was not sure how much disturbance it would take to wake the fellow. The next day was Monday, and he was not alone for a single minute until after supper, when, in near desperation, he took some books and went in search of an empty classroom. There, talking in a low tone to escape notice from anyone passing the door, he resumed the conversation with the Hunter.

"Something will have to be done about this," he said. "You can talk to me whenever I'm not actually doing something else; but I can't say anything to you when anyone is around without having them think I'm crazy. I've had an idea since last night, and have been wondering when I could tell you."

"The conversation problem should not be difficult," answered the Hunter. "If you simply talk in an inaudible whisper—even keep your lips closed, if you wish—I think I can learn quite easily to interpret the motions of your vocal chords and tongue. I should have thought of it long ago, but I had given no particular attention to the need for concealment with which we are faced. I shall practice interpretating those movements at once. It should not be hard; many of your people, I understand, become quite skilled at lip reading, and I have more than lips to go by. What was the idea you were so anxious to communicate?"

"I can see no way of our getting to the island, except through my getting sick and being ordered to take an early vacation. I can't possibly fake an illness well enough to fool a doctor; but you are in a position to give me all sorts of symptoms—enough to drive them crazy. How about it?"

The Hunter was a little hesitant in his answer.

"It is certainly a possibility, but there are objections. You cannot, of course, realize how deeply bred into us is the repugnance to the idea of doing anything that can harm our

hosts. In an emergency, with a being whose physical make-up I knew completely, I might carry out your plan as a last resort; in your case that is not true—I would have a hard time persuading myself that no permanent harm was going to result from my actions. Do you see?"

"You have lived in my body for over five months, and from what you told me of your nature, you must know my physical structure as well as you ever will," objected Bob.

"I know your structure, but not your tolerances," was the answer. "I do not know how long given cells can do without oxygen; what constitutes the limiting concentration of fatigue acids in your muscles; what interference your circulatory and nervous systems can stand. Those things obviously I could not test without harming and possibly killing you. There are, of course, a few things I could do, but the repugnance remains; and in my case, how do you know you would be sent back to the home of your parents? Would not the authorities be more likely to hospitalize you here?"

The question silenced Bob for several seconds; he had not thought of that possibility.

"I don't know," he said at last. "We'll have to find something that calls for a rest cure, I guess." The words brought a momentary wave of distaste; the term "rest cure" conveyed to the boy a picture of neurotic businessmen and hypochondriac old maids collected at a resort hotel he had once visited years before, when his parents had been visiting the United States and he had been young enough to be unpleasantly impressed by such surroundings. He said nothing more, however, determined in his own mind to go through with it if the Hunter agreed. That being was still reluctant to interfere with his host's vital processes, however, and refused to commit himself to any definite course of action. He said he would "think it over," and advised the boy to do the same—also, to produce another idea, if possible.

Bob terminated the conversation by leaving the room—unlikely as that may sound under the circumstances—and walked slowly down the corridor, thinking. He reviewed all the ideas he had already considered, and came to the same conclusion as before. As the Hunter more than suspected, though he had refrained from saying so, there was little chance of getting further constructive suggestions from Bob until his first presented idea was proved impossible rather than merely undesirable. The boy still liked the plan, and had no real conception of the emotion with which the Hunter viewed it.

Consequently, the only real progress made in the next few days was in communication. As the Hunter had expected and hoped, he was able quite quickly to learn to understand the motions of Bob's vocal chords and tongue, even when the boy kept

his lips nearly closed and spoke in a whisper almost inaudible to himself. Answering was easy, provided Bob's current occupation left him free to turn his eyes on some relatively blank space. The Hunter had never confessed to his host the chief contributing factor to the cut on his arm, but had no intention of repeating the error.

An observer during those few days, familiar with the course of events not only between Bob and his guest but in the offices of the school officials, would have been vastly amused; for on the one hand, the Hunter and his host were going quietly crazy trying to find an excuse for leaving, while on the other hand the headmaster and his staff were wondering about the cause of Robert Kinnaird's suddenly developed chronic inattention, listlessness, and general failure to measure up to his former standards of performance—and it had occurred to more than one of them that it might be better for the boy to get away for a time. The really amusing feature of the matter was, of course, the fact that the Hunter's mere presence was producing the set of conditions which was leading inevitably to the situation he desired—without the least effort on his part. He was doing the boy no physical damage, it is true, but preoccupation with the problem his guest presented and a number of too-public conversations with the concealed alien had produced an effect on Bob's general behavior that was only too noticeable to those responisble for his well-being.

The doctor was eventually consulted on the matter. He reported the boy's health sheet clean—no illnesses whatever during the current term, only two minor injuries—he examined the still healing arm again, on the chance that an unsuspected infection was responsible, but of course found nothing—and left the masters mystified. At their request he had a private interview with Robert.

The doctor learned nothing concrete from the conversation; but inevitably—the hypothetical watcher would have laughed again—he gained the perfectly correct impression that Bob had a problem on his mind which he did not care to share with anyone. Being a doctor, he formed a perfectly justified but quite erroneous theory on the nature of the problem, and recommended that the boy be returned to the care of his parents for a few months. It was as simple as that.

The headmaster wrote a letter to Mr. Kinnaird, explaining the situation as the doctor saw it, and stating that, if there were no objections, he planned to send the boy home until the opening of the fall term.

Bob's father rather doubted the doctor's theories, knowing his son remarkably well considering the time they had spent apart, but concurred with Mr. Raylance's suggestion—after all, if Bob was not doing well, it was a waste of time to have him at the school no matter what the

reason might be. There was a perfectly good doctor and—though Mrs. Kinnaird did not think so—a perfectly good school on the island, and it would be quite easy to fill the gap in his education while a more careful study of the situation was being made. Also, quite apart from these reasons, Mr. Kinnaird was glad of the chance to see more of his son. He wrote to the school authorizing the return of the boy, and prepared for his arrival.

To Robert and the Hunter, still buried in thought as they searched vainly for a plan, the news came as a stunning shock. The boy stared wordlessly at Mr. Raylance, who had called him to his office to inform him of the imminent journey; while the Hunter, staring through the same eyes, strove unsuccessfully to read a few papers which were exposed on the headmaster's desk. Eventually Bob recovered the use of his voice.

"But what is the reason, sir? Has anything happened at home?"

"No, everything is all right there. We felt that you might be better off there for a few months, that's all. You haven't been hitting your usual mark lately, have you?"

To the Hunter, this remark explained the situation with crystal clarity, and he metaphorically kicked himself for not foreseeing it; to Bob, understanding came more slowly.

"You mean . . . I'm being kicked out of school? I didn't think it was that bad."

"No, no, nothing of the sort. We noticed that you seemed to be having trouble, and the doctor thought you needed a little time off. We'll be glad to have you back next fall. If you like, we can send along a study outline with you, and the teacher there on the island can help you keep up with it. You can spread that work through the whole summer, and will probably be able to stay with your class when you come back. Is that all right? Or," the headmaster smiled, "is it just that you don't want to go home?"

Bob returned the smile rather lamely.

"Oh, I'll be glad enough to go, all right . . . I mean—" he paused, rather embarrassed as he realized a possible construction of his words. Mr. Raylance laughed aloud.

"All right, Bob," he said. "don't worry—I understand what you mean. You'd better get packed, and say good-by to your friends; I'll try to get you a reservation on the usual air route, for tomorrow. I'm sorry you're going; the hockey team will certainly miss you. However, the season is nearly over, and you'll be back in time for football. Good luck."

They shook hands, and Bob rather dazedly went to his room and began to pack. He said nothing to the Hunter; it was not necessary. He had long since given up taking the statements of his elders at face value

simply because they were his elders, but try as he might, he could find no ulterior motive lurking behind the words and actions of the headmaster. He decided for the time being to take his luck without question, and leave the next step to the Hunter.

That individual had ceased to worry from the time he had realized the import of the headmaster's words. The removal of a source of anxiety affected him almost as it does a human being—he tended to feel, for a time, as though troubles were a thing of the past. It might be too much to say that he felt his job was as good as done; but there would have been some excuse for his feeling that way. He was a good detective. He had, of course, some failures against his record; but not one of them had occurred while he had the advantage of an intelligent and co-operative host to supply the physical powers his own body lacked. Bob was not Jenver, but he had come to feel strongly attached to the youngster.

This atmosphere of nearly mindless bliss continued during Bob's packing, and even for part of the trip. Mr. Raylance was successful in obtaining the reservation, and the next day Bob took the bus to Boston and caught the noon plane to Seattle, where they were to change to the TPA plane. During the ride and the flight the boy talked with his guest whenever possible, but the conversation was purely about the events and scenes of the trip; and they did not turn to the subject in hand until they were over the Pacific. Even then, the Hunter was prone to take the matter for granted, amazing as it may seem; it was Bob who finally asked, "Just how are you going to find this friend of yours, and what will you do to him then? Have you some means of getting at him without hurting his host?"

For once, the Hunter was glad that his power of speech was less easily used than Bob's. Had it been otherwise, he would probably have uttered several words of assurance on just how simple the job was before his mind caught up with his tongue, and that would have been embarrassing. He had just been going over his blessings mentally—his possession of a perfect host from whose body he could operate in perfect concealment was the foremost of them; and in the next five seconds he wondered how he could have been so stupid; how the fact that his quarry must long since have found a hiding place at least as good as his own could possibly have escaped his attention so long. It was, of course, a normal situation, in a way—members of his race were hardly ever visible to the unaided senses, and had to be located by chemical and biochemical tests; but he should long since have faced the fact that *he had no means of making such tests.* He was hopelessly isolated from the police laboratories of his own world.

He remembered wryly how he had

thought of this point months before, and abandoned it for more immediate problems. Now *it* was the immediate problem, with a vengence. The confident air he had manifested in discussing it with Bob only a few days before had, coincidentally with the youngster's innocent question, evaporated completely. The summary they had made of the situation at that time was too glaringly accurate—they were looking for a needle in a very large haystack—containing, in fact, some two billion straws—and the needle—the deadly, poisoned needle!—had thoughtfully crawled inside one of them.

Bob got no answer to his question.

TO BE CONCLUDED

IN TIMES TO COME

I am at the moment looking at the June, 1949 cover, which is an unusual astronomical color plate—by Bonestell, of course—illustrating Philip Latham's story "The Aphrodite Project". The cover is, incidentally, strikingly beautiful, but our art department has been holding quite a discussion as to the name of the color on the top and bottom bands. (The color-plate has no printing on it; all type is on the bands.) Our engravers seem to have invented a new, and previously unnamed tint. Name it and you can have it!

In addition to Latham's article, we have an Old Doc Methuselah yarn by Lafayette. (This is one series in which the continuing hero is frankly and directly labeled as being deathless, incidentally; you won't often find an author admitting that.)

A. E. van Vogt is also present, with a novelette titled "The Green Forest" which introduces a new series, with an interesting type of opponent. The series, incidentally, might be compared to the series that started with "Co-operate—or Else," concerning the Ezwal. Interracial battle on a galactic scale is the background; conflicts between individual humans front and center on stage.

And, of course, there is the conclusion of "Needle," by Hal Clement. You know, incidentally, this yarn is one of the few detective stories in science-fiction that is legitimately a mystery which the reader has a chance to solve ahead of the detective. The setup rules out any of the detective's super-gadgets not known to the reader; his success must be—and is—based purely on observation and reasoning, with clues given the reader in full. The criminal is sheltered in plain sight, with sufficient clues to his hiding place. Also—can you figure a way to dislodge him?

THE EDITOR

PROPHECY

BY POUL ANDERSON

***It takes** time, and experience, for a child to grow up. The adult's been through the mill—yet it takes time and experience for a child to grow up. Maturity can't be taught. Perhaps races are the same—and the knowledge of it would be a grim and bitter medicine to take—*

Illustrated by Orban

Ambassadors are rarely, if ever, met by the head of the nation to which they come. They go to him. But this case was an exception to every established precedent, and the President of the United States, Philip Brackney, felt no loss in dignity as he came to the spaceship.

It was, he thought, really a lovely machine, with all the beauty of perfect functionalism—and something more than that, a touch of the haunting indefinable splendor of a clipper ship or a Greek temple. The five-

hundred-foot pylon towered over the green Iowan plain a blinding metallic dazzle in the sunlight, a spearhead poised at infinity. Its gleaming height dwarfed the buildings on the farm on which it had descended.

As the presidential car and its attendants swept up the dirt road—it was in extremely poor condition after the thousands of sightseers who had used it in the past month—the chief of Brackney's secret service guards said nervously: "For the last time, sir, are you sure this is wise?"

"Of course," he answered, a little irritable with excitement. "Any other procedure would be madness."

"But . . . if they have bad intentions—"

"Listen, Mr. Dickson, if they meant to do anything hostile, they'd do it. That one ship has more power than all this planet's combined military forces." The awe of it swept over Brackney, he breathed almost religiously: "A spaceship from the stars—and *men* aboard—"

The secretary of defense spoke slowly: "You know, every night for the past month I've gone down on my knees—and am not ashamed to admit it—to thank God that ship landed here. Not in some potential enemy's camp, but here—with us."

"It wouldn't have made any difference," said the president. "The visitors have been all over Earth in their lifeboats, seeing for themselves, taking almost all the printed matter they could get back. They probably have a better overall picture of Earth than we do."

He said, as the car swung up the driveway: "This is by rights not a matter for us at all. The United Nations alone should handle it, and they must take over soon. But—it was never set up to deal with ambassadors! I have to make the first official approach, for lack of anyone else."

The farmer stood nervously waiting. Since that rainy night a month gone when the ship landed in his pasture, he had lived in such a glare of publicity as to become a bit blasé about it. But after all—the president—

"I think they're waiting, sir," he mumbled.

"Very well. Come along, gentlemen." Brackney led the way.

A ramp had been lowered from the entrance lock, a hundred feet above ground. The party stepped on it and it rose smoothly up, with an uncanny, almost living flexibility.

For a moment, Brackney's throat was dry. A spaceship from the stars—*Don't be a fool!* he reproached himself sharply. *The Taithans have emphasized their friendliness a hundred times. They aren't conquistadores, they are representatives of a culture a thousand years ahead of ours—a culture that* must *have outgrown war, or the race would destroy itself with the weapons it has.*

The crew of the ship stood waiting at the lock. There were not many

of them, a score or so, and nearly all of these were scientists. The ship, they had said, practically ran itself. Nor were they at all spectacular. They looked like very ordinary human beings of a curiously mixed race—dark skin, Mongoloid eyes of a light shade, thin Caucasoid noses, woolly hair. They wore robes of a shimmering blue material, and had no outward insignia of rank.

"Greetings, gentlemen," said one, in accented but ready-flowing English. "Permit me to introduce myself—Gor Haml, the one of us who learned your language. The others, of course, have learned other tongues of your planet."

"I am Philip Brackney—" Introductions went around, acknowledged by the Taithans with grave bows. Thereafter Gor Haml led the way along a bare metal corridor and into a small—well, living room, thought Brackney, who was no sailor. It was furnished with chairs and tables of a comfortable, massive style, and there were some uncannily three-dimensional pictures on the walls. As the party sat down, they felt the chairs mold themselves to the body contours.

"I take it that the visit of such high dignitaries may be considered official?" asked Gor Haml.

"Certainly," replied Brackney. "But—may I ask if your own visit is in the nature of a formal embassy? Your refusal to admit anyone to your ship, or to hold other than the most academic discourse with those you met, until your invitation to me yesterday—that suggests you are on an official mission yourselves."

"Yes and no," answered the Taithan. "We are travelers, exploring this section of the Galaxy, but we are representatives of the Taithan people too, empowered to decide policy with regard to any world we visit."

"But why did you hold yourselves so aloof?" The secretary of state looked worried. "All Earth was ready to welcome you. Nearly all churches held thanksgiving services that you had come. Every government has besieged you with official congratulations and invitations."

Gor Haml seemed a little unhappy. "We have met great courtesy everywhere," he said, "but it is a rule of the exploration service not to perform any policy-making act until the new planet is—classified."

"I should hardly think a month would suffice for that," ventured Brackney.

Gor Haml rubbed a hand over his weary eyes. "It is grueling work," he admitted, "but it can be done, due to a combination of the highly evolved Taithan psychotechnology and certain phenomena of evolution and history. We have a very exact technique for dealing with human races."

"*Human* races!"

"Yes! it seems strange, but the fact is that in three hundred years of Galactic exploration the Taithans have never found an Earth-like world which was not inhabited by a

human race. Oh, there are differences, of course, and even races which look and think exactly alike could hardly be so similar as to make interbreeding possible—but by and large, the similarities exceed the differences."

"I should think the random element—"

"There is none, not if you agree that like causes produce like effects. All planets are produced by the same basic process, and so every Sol-type star *must* have a system like this one. And every Earth-type planet *must* produce the same general forms of life—because two processes beginning with the same initial conditions must run the same course."

"But how can the initial conditions be so much alike?"

"They are, in at least half the cases. There are deviations of greater or less degree, but over half the GO-type stars explored so far have been found to have planets similar to Taitha inhabited by an intelligent race similar to our own—and Earth is such a one." Gor Haml's eyes rested speculatively on the president. "We were astonished at this ourselves, when we first began exploring, but the fact was there. Now we know the reasons and see that such similarity is inevitable in this universe, but I cannot explain the philosophy to you. A thousand years from now, Earthlings should be able to understand it—but not at your present stage of development."

"I begin to see how you were able to learn about us so quickly," said Brackney. "You knew just about what to expect and what to look for."

"That is part of it, to be sure. Also, we have the benefits of a psychological science evolved to a point that might seem miraculous to you. It includes all human knowledge, which is after all only a function of the human organism, and integrates it according to principles your scientists and philosophers have not yet imagined. You have the germ of it in your experimental and analytical psychology, in semantics and symbolic logic, in physical and biological sciences, yes, and in some of your philosophical speculations. But you have not begun to exploit the potentialities of your own nervous systems. Taithans have no more inherent intelligence than Earthlings, but they know how to use it; just as a caveman was inherently capable of using, say, tensor analysis, but the knowledge did not exist for him. Thus we can perform such apparent feats of legerdemain as understanding and classifying a planet in a month's hard work."

"I see," nodded Brackney. "I can even guess your main line of approach—simply reading tons of written material of every kind, at some fantastic speed, and analyzing the information, both direct and indirect, it contains."

"That is one important line, at least," smiled the Taithan. "I might add that history books are the leading source of the knowledge we are after."

There was a moment of silence. The Earthlings sat looking at the strangers, seeking some sign of foreignness or of godlike power or—anything, rather than the score of weary-looking, ordinary men before them. Brackney, with a politician's sensitivity to moods, could not escape the nagging conviction that the Taithans were depressed. *They look at us as if they felt sorry for us!*

He said, more to break that awkward stillness than for any other reason: "I suppose this is a rather meaningless question, but how far ahead of our civilization is yours? I mean . . . well, of course we're contemporaries, but what time equivalent separates us—?" He stopped, acutely aware of his own lack of terminology.

"The question is not meaningless," replied Gor Haml. "We are about fifteen hundred years ahead of you—in actual time. Our recorded and archeological history is longer than yours by that many years. Indeed, that is the only significant difference between our races."

"That's quite encouraging," smiled the secretary of state. "I was beginning to fear you were the sort of supermen the fiction writers love—completely alien to us. But if you help us get started, we should be able to catch up with you in a generation or two."

"That . . . yes, that is why I have been so thankful," exclaimed Brackney. "Here on Earth we die of disease and war, we impoverish ourselves and go in fear and ignorance, we are bound to this one little planet—worse yet, to our own archaic superstitions and hates. Taithan science means things like spaceships and limitless energy sources and disease-free men, yes, and that's what all the world has been so jubilant about. But to me, it is the enlightenment and the freedom from our old heritage of cave and beast which is the great gift—" He stopped, a little embarrassed at his own loquacity. He heard his own blood beating in his veins, and his face was hot.

Gor Haml smiled. It was a very weary smile, with no humor in it, and his lined gaunt visage was not brightened by it. He said quietly:

"The histories of Earth and Taitha run as parallel as the histories of nearly all human races known to us. The only important difference is that ours is some fifteen hundred years older—but that difference is enormous. In the Galaxy so far, we have found human races in every stage from pure savagery to our own level, but in nearly every case—and your own among them—the only variation seems to be when they got started. Once under way, they follow the same patterns."

"But—hold on!" exploded Brackney. "You don't mean to say that on every planet there was an ancient Egypt and Rome, or a United States—?"

"Oh, no." Gor Haml's smile twitched with the faintest hint of amusement. "Indeed, the superficial

differences—language, dress, religion, laws and customs, almost everything which an untrained observer would notice—are usually radical. I am, however, speaking in a deeper sense. There is a parallelism in mental and, well, spiritual evolution which transcends outward appearances."

At their evident puzzlement, he went on: "I suppose some of you, at least, are familiar with such philosophers of history as Spengler and Toynbee. They have the beginnings of the truth, in their analysis of history into distinct cultures. And be it noted, those cultures follow a cycle of genesis in barbaric folk-wanderings, growth and expression of innate tendencies in the people, breakdown, time of troubles, stiffening into a 'universal state' statism, and ultimate extinction. The cycle has a time scale which varies by no more than ten or twenty years from the norm for each distinct stage.

"There is no reason to invoke a mysterious 'Destiny' to explain this fact. The casual law is sufficient. Under similar conditions, human beings react similarly. For instance, the nature myths of primitive peoples who never heard of each other are so alike that your own anthropologists have been able to classify them according to type, and to enunciate the unspoken beliefs underlying magic rites everywhere. In like manner, what is more natural than that outlying barbarians should invade a decadent empire and, coming under its influence, generate a new civilization—or that the miseries of a time of troubles should be forcibly ended by the imposition of a universal state? I am, of course, much oversimplifying, but I believe you can see in a rough way why Earth-type planets must evolve human races and why these races must have similar cycles of history."

"But history isn't all cyclic," objected Brackney.

"No, no, of course not. It is, indeed, an irreversible process only one of whose components, so to speak, is cyclic. For instance, the progress in technology is almost a direct line. Likewise, when a planet has advanced far enough, it is able to break out of the cycle of wars and other social evils—as Taitha has done. But the time of that achievement is governed by casual laws, not by wishful thinking or futile attempts at interference."

"Wait a minute—" A sudden fear, dim and inchoate, all the more ghastly for that, crawled coldly along Brackney's spine. "Wait! Aren't you assuming that conditions remain the same? For instance, your arrival on Earth is a factor which, I suppose, has no parallel on Taitha—"

"That is true." Suddenly Gor Haml's eyes were bright—with tears? "But when we depart, our brief visit will have had no long-range significance. Men tend to thrust unpleasant facts out of their minds, and the existence of planets immensely beyond Earth will prove unpleasant to most humans."

"Not . . . oh, no!" Brackney started out of his chair. "But you . . . you're going to stay! You're going to guide us, help us become truly civilized—"

"No, Mr. Brackney. We have classified Earth, and it is well below the stage of development at which prolonged contact with superior culture would be safe for either side. We leave immediately."

He stood up, and laid a hand on the president's shoulder. His face was bleak and stern and sorrowful. "Your assumption that we, whose intentions are admittedly benevolent, will give you guidance, is based on my own statement that Earthlings are intellectually capable of learning all that Taithans know. But man is not entirely, or even primarily, an intellectual animal. He has to *feel* his knowledge, if he is not to make hideous misuse of it. A wise man is not necessarily a good man, and intellect turns as readily to destructive as to useful ends. Do not forget the example of Japan, which your own people forced from feudalism to industrialism, without changing the inherent structure of society—thus loosing a fanatical menace on the world."

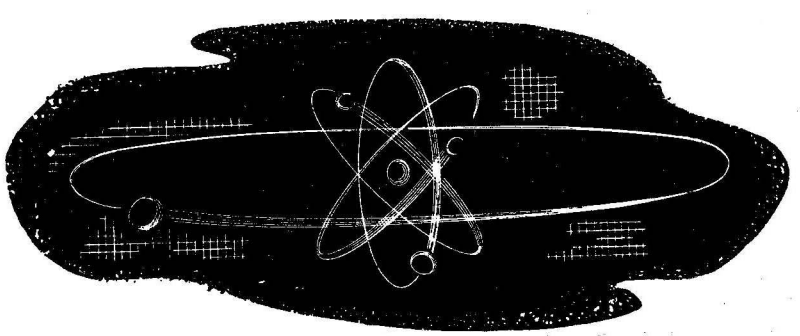
"But . . . you *would* change our society—wouldn't you?"

"Never. It would leave Earthlings pensioners, with no sense of cultural continuity—worse off than primitive aborigines forced into modern factories."

The grave, implacable voice seemed to come from enormous distances, gulfs of space and time and evolution. "Man must win his own salvation. He must learn, not only with his brain but with bitter and horrible and unforgettable experience, branded so deep as to be almost an instinct, that he is part of a whole, and that misuse of wisdom recoils a thousandfold.

"I am afraid that there is nothing we can do for you until you have had your atomic wars. We will be back in a thousand years. Good-by, gentlemen."

THE END



MOTHER EARTH

BY ISAAC ASIMOV

Illustrated by Orban

***The** logic of empire building as always in the past led to the decline of the mother country and the rise of the colonies. Now in the future, things will be—different or not?*

"But can you be certain? Are you sure that even a professional historian can always distinguish between victory and defeat?"

Gustav Stein, who delivered himself of that mocking question with a whiskered smile and a gentle wipe at the gray mustache from the neighborhood of which he had just removed an empty glass, was not an historian. He was a physiologist.

But his companion *was* an historian, and he accepted the gentle thrust with a smile of his own.

Stein's apartment was, for Earth, quite luxurious. It lacked the empty privacy of the Outer Worlds, of course, since from its window there stretched outward a phenomenon

that belonged only to the home planet—a city. A large city, full of people, rubbing shoulders, mingling sweat—

Nor was Stein's apartment fitted with its own power and its own utility supply. It lacked even the most elementary quota of positronic robots. In short, it lacked the dignity of self-sufficiency, and like all things on Earth, it was merely part of a community, a pendant unit of a cluster, a portion of a mob.

But Stein was an Earthman by birth and used to it. And after all, by Earth standards, the apartment was still luxurious.

It was just that looking outward through the same windows before which lay the city, one could see the stars and among them the Outer Worlds, where there were no cities but only gardens; where the lawns were streaks of emerald, where all human beings were kings, and where all good Earthmen earnestly and vainly hoped to go some day.

Except for a few who knew better—like Gustav Stein.

The Friday evenings with Edward Field belonged to that class of ritual which comes with age and quiet life. It broke the week pleasantly for two elderly bachelors, and gave them an innocuous reason to linger over the sherry and the stars. It took them away from the crudities of life, and, most of all, it let them talk.

Field, especially, as a lecturer, scholar and man of modest means quoted chapter and verse from his still uncompleted history of Terrestrian Empire.

"I wait for the last act," he explained. "Then I can call it the 'Decline and Fall of Empire' and publish it."

"You must expect the last act to come soon, then."

"In a sense, it has come already. It is just that it is best to wait for all to recognize that fact. You see, there are three times when an Empire or an Economic System or a Social Institution falls, you skeptic—"

Field paused for effect and waited patiently for Stein to say, "And those times are?"

"First," Field ticked off a right forefinger, "there is the time when just a little nub shows up that points an inexorable way to finality. It can't be seen or recognized until the finality arrives, when the original nub becomes visible to hindsight."

"And you can tell what that little nub is?"

"I think so, since I already have the advantage of a century and a half of hindsight. It came when the Sirian sector colony, Aurora, first obtained permission of the Central Government at Earth to introduce positronic robots into their community life. Obviously, looking back at it, the road was clear for the development of a thoroughly mechanized society based upon robot labor and not human labor. And it is this mechanization that has been and will yet be the deciding factor

in the struggle between the Outer Worlds and Earth."

"It is?" murmured the physiologist. "How infernally clever you historians are. What and where is the second time the Empire fell?"

"The second point in time," and Field gently bent his right middle finger backward, "arrives when a signpost is raised for the expert so large and plain that is can be seen even without the aid of perspective. And that point has been passed, too, with the first establishment of an immigration quota against Earth by the Outer Worlds. The fact that Earth found itself unable to prevent an action so obviously detrimental to itself was a shout for all to hear, and that was fifty years ago."

"Better and better. And the third point?"

"The third point?" Down went the ring finger. "That is the least important. That is when the signpost becomes a wall with a huge 'The End' scrawled upon it. The only requirement for knowing that the end has come then is neither perspective nor training, but merely the ability to listen to the video."

"I take it that the third point in time has not yet come."

"Obviously not, or you would not need to ask. Yet it may come soon, for instance, if there is war."

"Do you think there will be?"

Field avoided c o m m i t m e n t. "Times are unsettled, and a good deal of futile emotion is sweeping Earth on the immigration question. And if there should be a war, Earth would be defeated quickly and lastingly, and the wall would be erected."

"Can you be certain? Are you sure that even a professional historian can always distinguish between victory and defeat?"

Field smiled. He said: "You may know something I do not. For instance, they talk about something called the 'Pacific Project'."

"I never heard of it." Stein refilled the two glasses, "Let us speak of other things."

He held up his glass to the broad window so that the far stars flickered rosily in the clear liquid and said: "To a happy ending to Earth's troubles."

Field held up his own, "To the Pacific Project."

Stein sipped gently and said: "But we drink to two different things."

"Do we?"

It is quite difficult to describe any of the Outer Worlds to a native Earthman, since it is not so much a description of a world that is required as a description of a state of mind. The Outer Worlds—some fifty of them, originally colonies, later dominions, later nations—differ extremely among themselves in a physical sense. But the state of mind is somewhat the same throughout.

It is something that grows out of a world not originally congenial to mankind, yet populated by the cream of the difficult, the different, the daring, the deviant.

If it is to be expressed in a word, that word is "individuality."

There is the world of Aurora, for instance, three parsecs from Earth. It was the first planet settled outside the Solar System, and represented the dawn of interstellar travel. Hence its name.

It had air and water to start with, perhaps, but on Earthly standards, it was rocky and infertile. The plant life that did exist, sustained by a yellow-green pigment completely unrelated to chlorophyll, and not as efficient, gave the comparatively fertile regions a decidedly bilious and unpleasant appearance to unaccustomed eyes. No animal life higher than unicellular, and the equivalent of bacteria, as well, were present. Nothing dangerous naturally, since the two biological systems, of Earth and Aurora, were chemically unrelated.

Aurora became, quite gradually, a patchwork. Grains and fruit trees came first; shrubs, flowers, and grass afterward. Herds of livestock followed. And, as if it were necessary to prevent too close a copy of the mother planet, positronic robots also came to build the mansions, carve the landscapes, lay the power units. In short, to do the work, and turn the planet green and human.

There was the luxury of a new world and unlimited mineral resources. There was the splendid excess of atomic power laid out on new foundations with merely thousands, not billions, to service. There was the vast flowering of physical science, in worlds where there was room for it.

Take the home of Franklin Maynard, for instance, who, with his wife, three children, and twenty-seven robots lived on an estate more than forty miles away, in distance, from the nearest neighbor. Yet by community-wave he could, if he wished, share the living room of any of the seventy-five million on Aurora—with each singly; with all simultaneously.

Maynard knew every inch of his valley. He knew just where it ended, sharply, and gave way to the alien crags, along whose undesirable slopes the angular, sharp leaves of the native furze clung sullenly—as if in hatred of the softer matter that had usurped its place in the sun.

Maynard did not have to leave that valley. He was a deputy in the Gathering, and a member of the Foreign Agents Committee, but he could transact all business, but the most extremely essential, by community-wave, without ever sacrificing that precious privacy he had to have in a way no Earthman could understand.

Even the present business could be performed by community-wave. The man, for instance, who sat with him in his living room, was Charles Hijkman, and he, actually, was sitting in his own living room on an island in an artificial lake stocked with fifty varieties of fish, which happened to be twenty-five hundred miles distant, in space.

The connection was an illusion, of course. If Maynard were to reach out a hand, he could feel the invisible wall.

Even the robots were quite accustomed to the paradox, and when Hijkman raised a hand for a cigarette, Maynard's robot made no move to satisfy the desire, though a half-minute passed before Hijkman's own robot could do so.

The two men spoke like Outer Worlders, that is, stiffly and in syllables too clipped to be friendly, and yet certainly not hostile. Merely undefinably lacking in the cream—however sour and thin at times—of human sociability which is so forced upon the inhabitants of Earth's ant heaps.

Maynard said: "I have long wanted a private communion, Hijkman. My duties in the Gathering, this year—"

"Quite. That is understood. You are welcome now, of course. In fact, especially so, since I have heard of the superior nature of your grounds and landscaping. Is it true that your cattle are fed on imported grass?"

"I'm afraid that is a slight exaggeration. Actually, certain of my best milkers feed on Terrestrial imports during calving time, but such a procedure would be prohibitively expensive, I'm afraid, if made general. It yields quite extraordinary milk, however. May I have the privilege of sending you a day's output?"

"It would be most kind of you." Hijkman bent his head, gravely. "You must receive some of my salmon in return."

To a Terrestrial eye, the two men might have appeared much alike. Both were tall, though not unusually so for Aurora, where the average height of the adult male is six feet one and one half inches. Both were blond and hard-muscled, with sharp and pronounced features. Though neither was younger than forty, middle-age as yet sat lightly upon them.

So much for amenities. Without a change in tone, Maynard proceeded to the serious purpose of his call.

He said: "The Committee, you know, is now largely engaged with Moreanu and his Conservatives. We would like to deal with them firmly, we of the Independents, that is. But before we can do so with the requisite calm and certainty, I would like to ask you certain questions."

"Why me?"

"Because you are Aurora's most important physicist."

Modesty is an unnatural attitude, and one which is only with difficulty taught to children. In an individualistic society it is useless and Hijkman was, therefore, unencumbered with it. He simply nodded objectively at Maynard's last words.

"And," continued Maynard, "as one of us. You are an Indedendent."

"I am a member of the Party. Dues-paying, but not very active."

"Nevertheless safe. Now, tell me, have you heard of the Pacific Project?"

"The Pacific Project?" There was a polite inquiry in his words.

"It is something which is taking place on Earth. The Pacific is a Terrestrial ocean, but the name itself probably has no significance."

"I have never heard of it."

"I am not surprised. Few have, even on Earth. Our communion, by the way, is via tight-beam and nothing must go further."

"I understand."

"Whatever Pacific Project is—and our agents are extremely vague—it might conceivably be a menace. Many of those who on Earth pass for scientists seem to be connected with it. Also, some of Earth's more radical and foolish politicians."

"Hm-m-m. There was once something called the Manhattan Project—"

"Yes," urged Maynard, "what about it?"

"Oh, it's an ancient thing. It merely occurred to me because of the analogy in names. The Manhattan Project was before the time of extra-terrestrial travel. Some petty war in the dark ages occurred, and it was the name given to a group of scientists who developed atomic power."

"Ah," Maynard's hand became a fist, "and what do you think the Pacific Project can do then?"

Hijkman considered. Then, softly: "Do you think Earth is planning war?"

On Maynard's face there was a sudden expression of distaste. "Six billion people. Six billion half-apes rather jammed into one system to a near-explosion point, facing only two hundred million of us, total. Don't you think it is a dangerous situation."

"Oh, numbers!"

"All right. Are we safe despite the numbers? Tell me. I'm only an administrator, and you're a physicist. *Can* Earth win a war in any way?"

Hijkman sat solemnly in his chair and thought carefully and slowly. Then he said: "Let us reason. There are three broad classes of methods whereby an individual or group can gain his ends against opposition. On an increasing level of subtlety, those three classes can be termed the physical, the biological, and the psychological.

"Now the physical can be easily eliminated. Earth does not have an industrial background. It does not have a technical know-how. It has very limited resources. It lacks even a single outstanding physical scientist. So it is as impossible as anything in the Galaxy can be that they can develop any form of physico-chemical application that is not already known to the Outer Worlds. Provided, of course, that the conditions of the problem imply single-handed opposition on the part of Earth against any or all of the Outer Worlds. I take it that none of the Outer Worlds intends leaguing with Earth against us."

Maynard indicated violent opposition even to the suggestion, "No, no, no. There is no question of that. Put it out of your mind."

"Then ordinary physical surprise weapons are inconceivable. It is useless to discuss it further."

"Then what about your second class, the biological."

Slowly, Hijkman lifted his eyebrows: "Now that is less certain. Some Terrestrial biologists are quite competent, I am told. Naturally, since I am myself a physicist, I am not entirely qualified to judge this. Yet I believe that in certain restricted fields, they are still expert. In agricultural science, of course, to give an obvious example. And in bacteriology. Um-m-m—"

"Yes, what about bacteriological warfare."

"A thought! But no, no, quite inconceivable. A teeming constricted world such as Earth cannot afford to fight an open latticework of fifty sparse worlds with germs. They are infinitely more subject to epidemics, that is, to retaliation in kind. In fact, I would say that given our living conditions here on Aurora and on the other Outer Worlds, no contagious disease could really take hold. No, Maynard. You can check with a bacteriologist, but I think he'll tell you the same."

Maynard said: "And the third class?"

"The psychological? Now that is unpredictable. And yet the Outer Worlds are intelligent and healthy communities and not amenable to ordinary propaganda, or for that matter to any form of unhealthy emotionalism. Now, I wonder—"

"Yes?"

"What if the Pacific Project is just that. I mean, a huge device to keep us off balance. Something top-secret, but meant to leak out in just the right fashion, so that the Outer Worlds yield a little to Earth, simply in order to play safe."

There was a longish silence.

"Impossible," burst out Maynard, angrily.

"*You* react properly. *You* hesitate. But I don't seriously press the interpretation. It is merely a thought."

A longer silence, then Hijkman spoke again: "Are there any other questions?"

Maynard started out of a reverie, "No . . . no—"

The wave broke off and a wall appeared where space had been a moment before.

Slowly, with stubborn disbelief, Franklin Maynard shook his head.

Ernest Keilin mounted the stairs with a feeling for all the past centuries. The building was old, cobwebbed with history. It once housed the Parliament of Man, and from it words went out that clanged throughout the stars.

It was a tall building. It soared —stretched—strained. Out and up to the stars, it reached; to the stars that had now turned away.

It no longer even housed the

Parliament of Earth. That had now been switched to a newer, neoclassical building, one that imperfectly aped the architectural stylisms of the ancient pre-Atomic age.

Yet the older building still held its great name. Officially, it was still Stellar House, but it only housed the functionaries of a shriveled bureaucracy now.

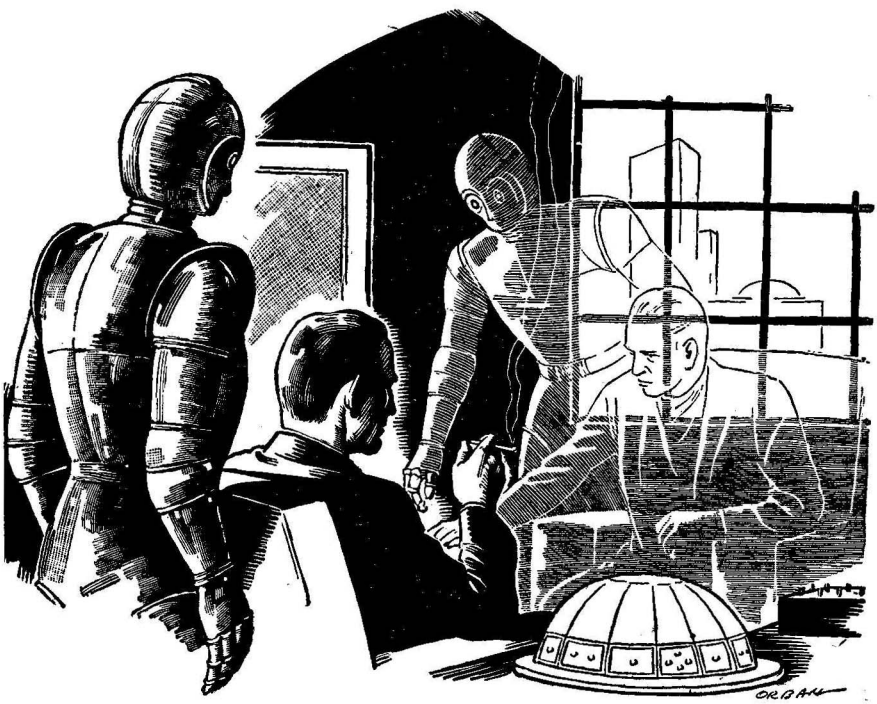
Keilin got out at the twelfth floor, and the lift dropped quickly down behind him. The radiant sign said smoothly and quietly: Bureau of Information. He handed a letter to the receptionist. He waited. And eventually, he passed through the door which said, "L. Z. Cellioni—Secretary of Information."

Cellioni was little and dark. His hair was thick and black; his mustache thin and black. His teeth, when he smiled, were startlingly white and even—so he smiled often.

He was smiling now, as he rose and held out his hand. Keilin took it, then an offered seat, then an offered cigar.

Cellioni said: "I am very happy to see you, Mr. Keilin. It is kind of you to fly here from New York on such short notice."

Keilin curved the corners of his lips down and made a tiny gesture



with one hand, deprecating the whole business.

"And now," continued Cellioni, "I presume you would like an explanation of all this."

"I wouldn't refuse one," said Keilin.

"Unfortunately, it is difficult to know exactly how to explain. As Secretary of Information, my position is difficult. I must safeguard the security and well-being of Earth and, at the same time, observe our traditional freedom of the press. Naturally, and fortunately, we have no censorship, but just as naturally, there are times when we could almost wish we did have."

"Is this," asked Keilin, "with reference to me? About censorship, I mean?"

Cellioni did not answer directly. Instead, he smiled again, slowly, and with a remarkable absence of joviality.

He said: "You, Mr. Keilin, have one of the most widely heard and influential talecasts on the video. Therefore, you are of peculiar interest to the government."

"The time is mine," said Keilin, stubbornly. "I pay for it. I pay taxes on the income I derive from it. I adhere to all the common-law rulings on taboos. So I don't quite see of what interest I can be to the government."

"Oh, you misunderstand me. It's my fault, I suppose, for not being clearer. You have committed no crime; broken no laws. I have only admiration for your journalistic ability. What I refer to is your editorial attitude at times."

"With respect to what?"

"With respect," said Cellioni, with a sudden harshness about his thin lips, "to our policy toward the Outer Worlds."

"My editorial attitude represents what I feel and think, Mr. Secretary."

"I allow this. You have your right to your feelings and your thoughts. Yet it is injudicious to spread them about nightly to an audience of half a billion."

"Injudicious, according to you, perhaps. But legal, according to anybody."

"It is sometimes necessary to place good of country above a strict and selfish interpretation of legality."

Keilin tapped his foot twice and frowned blackly.

"Look," he said, "put this frankly. What is it you want?"

The Secretary of Information spread his hands out before him. "In a word—co-operation! Really, Mr. Keilin, we can't have you weakening the will of the people. Do you appreciate the position of Earth? Six billions, and a declining food supply! It is insupportable! And emigration is the only solution. No patriotic Earthman can fail to see the justice of our position. No reasonable human being anywhere can fail to see the justice of it."

Keilin said: "I agree with your premise that the population problem is serious, but emigration is not

the only solution. In fact, emigration is the one sure way of hastening destruction."

"Really? And why do you say that?"

"Because the Outer Worlds will not permit emigration, and you can force their hand by war only. *And we cannot win a war.*"

"Tell me," said Cellioni softly, "have *you* ever tried emigrating. It seems to me you could qualify. You are quite tall, rather light-haired, intelligent—"

The video-man flushed. He said, curtly: "I have hay fever."

"Well," and the secretary smiled, "then you must have good reason for disapproving their arbitrary genetic and racist policies."

Keilin replied with heat: "I won't be influenced by personal motives. I would disapprove their policies, if I qualified perfectly for emigration. But my disapproval would alter nothing. Their policies *are* their policies, and they can enforce them. Moreover, their policies have some reason even if wrong. Mankind is starting again on the Outer Worlds, and they—the ones who got there first—would like to eliminate some of the flaws of the human mechanism that have become obvious with time. A hay fever sufferer *is* a bad egg—genetically. A cancer prone even more so. Their prejudices against skin and hair colors are, of course, senseless, but I can grant that they are interested in uniformity and homogeneity. And as for Earth, we can do much even without the help of the Outer Worlds."

"For instance, what?"

"Positronic robots and hydroponic farming should be introduced, and—most of all—birth control must be instituted. An intelligent birth control, that is, based on firm psychiatric principles intended to eliminate the psychotic trends, congenital infirmities—"

"As they do in the Outer Worlds—"

"Not at all. I have mentioned no racist principles. I talk only of mental and physical infirmities that are held in common by all ethnic and racial groups. And most of all, births must be held below deaths until a healthful equilibrium is reached."

Cellioni said, grimly: "We lack the industrial techniques and the resources to introduce a robot-hydroponic technology in anything less than five centuries. Furthermore, the traditions of Earth, as well as current ethical beliefs forbid robot labor and false foods. Most of all, they forbid the slaughter of unborn children. Now come, Keilin, we can't have you pouring this out over video. It won't work; it distracts the attention; it weakens the will."

Keilin broke in, impatiently: "Mr. Secretary, do you want war?"

"Do I *want* war? That is an impudent question."

"Then who are the policy-makers in the government who *do* want war? For instance, who is respon-

sible for the calculated rumor of the Pacific Project."

"The Pacific Project? And where did you hear of that?"

"My sources are my secret."

"Then I'll tell you. You heard of this Pacific Project from Moreanu of Aurora on his recent trip to Earth. We know more about you than you suppose, Mr. Keilin."

"I believe that, but I do not admit that I received information from Moreanu. Why do you think I could get information from him? Is it because he was deliberately allowed to learn of this piece of trumpery."

"Trumpery?"

"Yes. I think Pacific Project is a fake. A fake meant to inspire confidence. I think that the government plans to let the so-called secret leak out in order to strengthen its war policy. It is part of a war of nerves on Earth's own people, and it will be the ruin of Earth in the end.

"And I will take this theory of mine to the people."

"You will not, Mr. Keilin," said Cellioni, quietly.

"I will."

"Mr. Keilin, your friend, Ion Moreanu is having his troubles on Aurora, perhaps for being too friendly with you. Take care that you do not have equal trouble for being too friendly with him."

"I'm not worried." The video man laughed shortly, lunged to his feet and strode to the door.

Keilin smiled very gently when he found the door blocked by two large men: "You mean I am under arrest right now."

"Exactly," said Cellioni.

"On what charge?"

"We'll think of some later."

Keilin left—under escort.

On Aurora, the mirror image of the afore-described events was taking place, and on a larger scale.

The Foreign Agents Committee of the Gathering had been meeting now for days—ever since the session of the Gathering in which Ion Moreanu and his Conservative Party made their great bid to force a vote of no confidence. That it had failed was in part due to the superior political generalship of the Independents, and in some part due to the activity of this same Foreign Agents Committee.

For months now the evidence had been accumulating, and when the vote of confidence turned out to be sizably in favor of the Independents, the Committee was able to strike in its own way.

Moreanu was subpoenaed in his own home, and placed under house arrest. Although this procedure of house arrest was not, under the circumstances, legal—a fact emphatically pointed out by Moreanu —it was nevertheless successfully accomplished.

For three days Moreanu was cross-examined thoroughly, in polite, even tones that scarcely ever veered from unemotional curiosity. The seven inquisitors of the Committee

took turns in questioning, but Moreanu had respite only for ten-minute intervals during the hours in which the Committee sat.

After three days, he showed the effects. He was hoarse with demanding that he be faced with his accusers; weary with insisting that he be informed of the exact nature of the charges; throat-broken with shouting against the illegality of the procedure.

The Committee finally read statements at him—

"Is this true or not? Is this true or not?"

Moreanu could merely shake his head wearily as the structure spidered about him.

He challenged the competency of the evidence and was smoothly informed that the proceedings constituted a Committee Investigation and not a trial—

The chairman clapped his gavel finally. He was a broad man of tremendous purpose. He spoke for an hour in his final summing up of the results of the inquiry, but only a relatively short portion of it need be quoted.

He said: "If you had merely conspired with others on Aurora, we could understand you; even forgive you. Such a fault would have been held in common with many ambitious men in history. It is not that at all. What horrifies us and removes all pity is your eagerness to consort with the disease-ridden, ignorant and subhuman remnants of Earth.

"You, the accused, stand here under a heavy weight of evidence showing you to have conspired with the worst elements of Earth's mongrel population—"

The chairman was interrupted by an agonized cry from Moreanu, "But the motive! What motive can you possibly attribute—"

The accused was pulled back into his seat. The chairman pursed his lips and departed from the slow gravity of his prepared speech to improvise a bit.

"It is not," he said, "for this Committee to go into your motives. We have shown the facts of the case. The Committee *does* have evidence—" He paused, and looked along the line of the members to the right and the left, then continued. "I think I may say that the Committee has evidence that points to your intentions to use Earth man power to engineer a coup that would leave you dictator over Aurora. But since the evidence has not been used, I will not go further into that, except to say that such a consummation is not inconsistent with your characters displayed at these hearings."

He went back to his speech. "Those of us who sit here have heard, I think, of something termed the 'Pacific Project', which, according to rumors, represents an attempt on the part of Earth to retrieve its lost dominions.

"It is needless to emphasize here that any such attempt must be doomed to failure. And yet defeat

for us is not entirely inconceivable. One thing can cause us to stumble, and that one thing is an unsuspected internal weakness. Genetics is, after all, still an imperfect science. Even with twenty generations behind us, undesirable traits may crop up at scattered points, and each represents a flaw in the steel shield of Aurora's strength.

"*That* is the Pacific Project—the use of our own criminals and traitors against us; and if they can find such in our inner councils, the Earthmen might even succeed.

"The Foreign Agents Committee exists to combat that threat. In the accused, we touch the fringes of the web. We must go on—"

The speech did, at any rate.

When it was concluded, Moreanu, pale, wild-eyed, pounded his fist, "I demand my say—"

"The accused may speak," said the chairman.

Moreanu rose and looked about him for a long moment. The room, fitted for an audience of seventy-five million by Community Wave, was unattended. There were the inquisitors, legal staff, official recorders—And with him, in the actual flesh, his guards.

He would have done better with an audience. To whom could he otherwise appeal? His glance fled hopelessly from each face it touched, but could find nothing better.

"First," he said, "I deny the legality of this meeting. My constitutional rights of privacy and individuality have been denied. I have been tried by a group without standing as a court, by individuals convinced, in advance, of my guilt. I have been denied adequate opportunity to defend myself. In fact, I have been treated throughout as an already convicted criminal requiring only sentence.

"I deny, completely and without reservation, that I have been engaged in any activity detrimental to the state or tending to subvert any of its fundamental institutions.

"I accuse, vigorously and unreservedly, this Committee of deliberately using its powers to win political battles. I am guilty not of treason, but of disagreement. I disagree with a policy dedicated to the destruction of the larger part of the human race for reasons that are trivial and inhumane.

"Rather than destruction, we owe assistance to these men who are condemned to a harsh, unhappy life solely because it was our ancestors and not theirs who happened to reach the Outer Worlds first. With our technology and resources, they can yet recreate and redevelop—"

The chairman's voice rose above the intense near-whisper of Moreanu: "You are out of order. The Committee is quite prepared to hear any remarks you make in your own defense, but a sermon on the rights of Earthmen is outside the legitimate realm of the discussion."

The hearings were formally closed. It was a great political victory for the Independents; all would

agree to that. Of the members of the Committee, only Franklin Maynard was not completely satisfied. A small nagging doubt remained.

He wondered—

Should he try one last time? Should he speak once more and then no more to that queer little monkey ambassador from Earth? He made his decision quickly and acted upon it instantly. Only a pause to arrange a witness, since even for himself an unwitnessed private communion with an Earthman might be dangerous.

Luiz Moreno, Ambassador to Aurora from Earth, was, to put not too fine a point on it, a miserable figure of a man. And that wasn't exactly an accident. On the whole, the foreign diplomats of Earth tended to be dark, short, wizen, or weakly—or all four.

That was only self-protection since the Outer Worlds exerted strong attraction for any Earthman. Diplomats exposed to the allure of Aurora, for instance, could not but be exceedingly reluctant to return to Earth. Worse, and more dangerous, exposure meant a growing sympathy with the demigods of the stars and a growing alienation from the slum-dwellers of Earth.

Unless, of course, the ambassador found himself rejected. Unless, he found himself somewhat despised. And then, no more faithful servant of Earth could be imagined, no man less subject to corruption.

The Ambassador to Earth was only five foot two, with a bald head and receding forehead, a pinkish affectation of beard and red-rimmed eyes. He was suffering from a slight cold, the occasional results whereof he smothered in a handkerchief. And yet, withal, he was a man of intellect.

To Franklin Maynard, the sight and sound of the Earthman was distressing. He grew queasy at each cough and shuddered when the ambassador wiped his nose.

Maynard said: "Your excellency, we commune at my request because I wish to inform you that the Gathering has decided to ask your recall by your government."

"That is kind of you, councilor. I had an inkling of this. And for what reason?"

"The reason is not within the bounds of discussion. I believe it is the prerogative of a sovereign state to decide for itself whether a foreign representative shall be *persona grata* or not. Nor do I think you really need enlightenment on this matter."

"Very well, then." The ambassador paused to wield his handkerchief and murmur an apology. "Is that all?"

Maynard said: "Not quite. There are matters I would like to mention. Remain!"

The ambassador's reddened nostrils flared a bit, but he smiled, and said: "An honor."

"Your world, excellency," said Maynard, superciliously, "displays a certain belligerence of late that we

on Aurora find most annoying and unnecessary. I trust that you will find your return to Earth at this point a convenient opportunity to use your influence against further displays such as recently occurred in New York where two Aurorans were manhandled by a mob. The payment of an indemnity may not be enough the next time."

"But that is emotional overflow, Councilor Maynard. Surely, you cannot consider youngsters shouting in the streets to be adequate representations of belligerence."

"It is backed by your government's actions in many ways. The recent arrest of Mr. Ernest Keilin, for instance."

"Which is a purely domestic affair," said the ambassador, quietly.

"But not one to demonstrate a reasonable spirit toward the Outer Worlds. Keilin was one of the few Earthmen who until recently could yet make their voices heard. He was intelligent enough to realize that no divine right protects the inferior man simply because he is inferior."

The ambassador arose: "I am not interested in Auroran theories on racial differences."

"A moment. Your government may realize that much of their plans have gone awry with the arrest of your agent, Moreanu. Stress the fact that we of Aurora are much wiser than we have been prior to this arrest. It may serve to give them pause."

"Is Moreanu *my* agent? Really, councilor, if I am disaccredited, I shall leave. But surely the loss of diplomatic immunity does not affect my personal immunity as an honest man from charges of espionage."

"Isn't that your job?"

"Do Aurorans take it for granted that espionage and diplomacy are identical? My government will be glad to hear it. We shall take appropriate precautions."

"Then you defend Moreanu? You deny that he has been working for Earth."

"I defend only myself. As to Moreanu, I am not stupid enough to say anything."

"Why stupid?"

"Wouldn't a defense by myself be but another indictment against him? I neither accuse nor defend him. Your government's quarrel with Moreanu, like my government's with Keilin—whom you, by the way, are most suspiciously eager to defend—is an internal affair. I will leave now."

The communion broke, and almost instantly the wall faded again. Hijkman was looking thoughtfully at Maynard.

"What do you think of him?" asked Maynard, grimly.

"Disgraceful that such a travesty of humanity should walk Aurora, I think."

"I agree with you, and yet . . . and yet—"

"Well?"

"And yet I can almost find myself able to think that he is the master

and that we dance to his piping. You know of Moreanu?"

"Of course."

"Well, he will be convicted; sent to an asteroid. His party will be broken. Offhand, anyone would say that such actions represent a horrible defeat for Earth."

"Is there doubt in your mind that such is the case?"

"I'm not sure. Committee Chairman Hond insisted on airing his theory that Pacific Project was the name Earth gave to a device for using internal traitors on the Outer Worlds. But I don't think so. I'm not sure the facts fit that. For instance, where did we get our evidence against Moreanu?"

"I certainly can't say."

"Our agents, in the first place. But how did they get it? The evidence was a little *too* convincing. Moreanu could have guarded himself better—"

Maynard hesitated. He seemed to be attempting a blush, and failing. "Well, to put it quickly, I think it was the Terrestrian Ambassador who somehow presented us with the most evidence. I think that he played on Moreanu's sympathy for Earth first to befriend him and then to betray him."

"Why?"

"I don't know. To insure war, perhaps—with this Pacific Project waiting for us."

"I don't believe it."

"I know. I have no proof. Nothing but suspicion. The Committee wouldn't believe me either. It seemed to me, perhaps, that a last talk with the ambassador might reveal something, but his mere appearance antagonizes me, and I find I spend most of my time trying to remove him from my sight."

"Well, you are becoming emotional, my friend. It is a disgusting weakness. I hear that you have been appointed a delegate to the Interplanetary Gathering at Hesperus. I congratulate you."

"Thanks," said Maynard, absently.

Luiz Moreno, ex-Ambassador to Aurora, had been glad to return to Earth. He was away from the artificial landscapes that seemed to have no life of their own, but to exist only by virtue of the strong will of their possessors. Away from the too-beautiful men and women and from their ubiquitous, brooding robots.

He was back to the hum of life and the shuffle of feet; the brushing of shoulders and the feeling of breath in the face.

Not that he was able to enjoy these sensations entirely. The first days had been spent in lively conferences with the heads of Earth's government.

In fact, it was not till nearly a week had passed, that an hour came in which he could consider himself truly relaxed.

He was in the rarest of all appurtenances of Terrestrial Luxury—a roof garden. With him was Gustav Stein, the quite obscure physi-

ologist, who was, nevertheless, one of the prime movers of the Plan, known to rumor as the Pacific Project.

"The confirmatory tests," said Moreno, with an almost dreadful satisfaction, "all check so far, do they not?"

"So far. *Only* so far. We have miles to go."

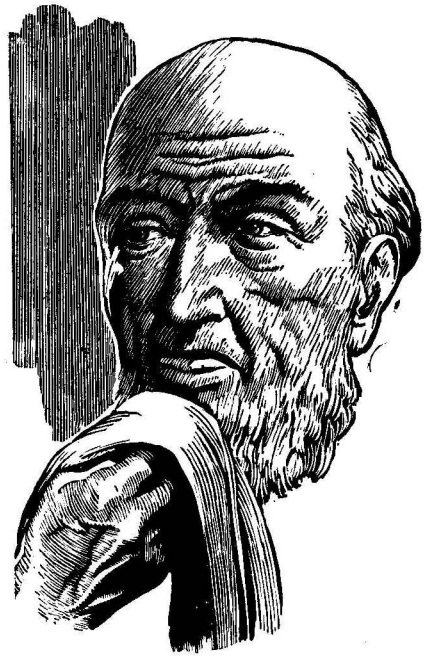
"Yet they will continue to go well. To one who has lived on Aurora for nearly a year as I have, there can be no doubt but that we're on the right track."

"Um-m-m. Nevertheless, I will go only by the laboratory reports."

"And quite rightly." His little body was almost stiff with gloating. "Some day, it will be different. Stein, you have not met these men, these Outer Worlders. You may have come across the tourists, perhaps, in their special hotels, or riding through the streets in inclosed cars, equipped with the purest of private, air-conditioned atmospheres for their well-bred nostrils; observing the sights through a movable periscope and shuddering away from the touch of an Earthman.

"But you have not met them on their own world, secure in their own sickly, rotting greatness. Go, Stein, and be despised a while. Go, and find how well you can compete with their own trained lawns as something to be gently trod upon.

"And yet, when I pulled the proper cords, Ion Moreanu fell—Ion Moreanu, the only man among them with the capacity to understand the workings of another's mind. It is the crisis that we have passed now. We front a smooth path now."



Satisfaction! Satisfaction!

"As for Keilin," he said suddenly, more to himself than to Stein, "he can be turned loose, now. There's little he can say, hereafter, that can endanger anything. In fact, I have an idea. The Interplanetary Conference opens on Hesperus within the month. He can be sent to report the meeting. It will be an earnest of our friendliness—and keep him away for the summer. I think it can be arranged."

It was.

Of all the Outer Worlds, Hesperus was the smallest, the latest settled, the furthest from Earth. Hence the name. In a physical sense, it was not best suited to a great diplomatic gathering, since its facilities were small. For instance, the available community-wave network could not possibly be stretched to cover all the delegates, secretarial staff, and administrators necessary in a convocation of fifty planets. So meetings in person were arranged in buildings impressed for the purpose.

Yet there was a symbolism in the choice of meeting place that escaped practically nobody. Hesperus, of all the Worlds, was furthest removed from Earth. But the spatial distance—one hundred parsecs or more—was the least of it. The important point was that Hesperus had been colonized not by Earthmen, but by men from the Outer World of Faunus.

It was therefore of the second generation, and so it had no "Mother Earth." Earth to it was but a vague grandmother, lost in the stars.

As is usual in all such gatherings, little work is actually done on the session floors. That space is reserved for the official soundings of whatever is primarily intended for home ears. The actual swapping and horse-trading takes place in the lobbies and at the lunch-tables and many an irresolvable conflict has softened over the soup and vanished over the nuts.

And yet particular difficulties were present in this particular case. Not in all worlds was the community-wave as paramount and all-pervading as it was on Aurora, but it was prominent in all. It was, therefore, with a certain sense of outrage and loss that the tall, dignified men found it necessary to approach one another in the flesh, without the comforting privacy of the invisible wall between, without the warm knowledge of the break-switch at their fingertips.

They faced one another in uneasy semi-embarrassment and tried not to watch one another eat; tried not to shrink at the unmeant touch. Even robot service was rationed.

Ernest Keilin, the only accredited video-representative from Earth, was aware of some of these matters only in the vague way they are described here. A more precise insight he could not have. Nor could anyone brought up in a society where human beings exist only in the plural, and where a house need only be deserted to be feared.

So it was that certain of the most subtle tensions escaped him at the formal dinner party given by the Hesperian government during the third week of the conference. Other tensions, however, did not pass him by.

The gathering after the dinner naturally fell apart into little groups. Keilin joined the one that contained Franklin Maynard of Aurora. As the delegate of the largest of the Worlds, he was naturally the most newsworthy.

Maynard was speaking casually between sips at the tawny Hesperian cocktail in his hand. If his flesh crawled slightly at the closeness of the others, he masked the feeling masterfully.

"Earth," he said, "is, in essence, helpless against us if we avoid unpredictable military adventures. Economic unity is actually a necessity, if we intend to avoid such adventures. Let Earth realize to how great an extent her economy depends upon us, on the things that we alone can supply her, and there will be no more talk of living space. And if we are united, Earth would never dare attack. She will exchange her barren longings for atomic motors—or not, as she pleases."

And he turned to regard Keilin with a certain hauteur as the other found himself stung to comment:

"But your manufactured goods, councilor—I mean those you ship to Earth—they are not *given* us. They are exchanged for agricultural products."

Maynard smiled silkily. "Yes, I believe the delegate from Tethys has mentioned that fact at length. There is a delusion prevalent among some of us that only Terrestrial seeds grow properly—"

He was interrupted calmly by another, who said: "Now I am not from Tethys, but what you mention is not a delusion. I grow rye on Rhea, and I have never yet been able to duplicate Terrestrial bread. It just hasn't got the same taste." He addressed the audience in general, "In fact, I imported half a dozen Terrestrians five years back on agricultural laborer visas so they could oversee the robots. Now they can do wonders with the land, you know. Where they spit, corn grows fifteen feet high. Well, that helped a little. And using Terrestrian seed helped. But even if you grow Terrestrian grain, its seed won't hold the next year."

"Has your soil been tested by your government's agricultural department?" asked Maynard.

The Rhean grew haughty in his turn: "No better soil in the sector. And the rye is top-grade. I even sent a hundredweight down to Earth for nutritional clearance, and it came back with full marks." He rubbed one side of his chin, thoughtfully: "It's flavor I'm talking about. Doesn't seem to have the right—"

Maynard made an effort to dismiss him: "Flavor is dispensable temporarily. They'll be coming to us on our terms, these little-men-hordes of Earth, when they feel the pinch. We give up only this mysterious flavor, but they will have to give up atom-powered engines, farm machinery, and ground cars. It wouldn't be a bad idea, in fact, to attempt to get along without the Terrestrian flavors you are so concerned about. Let us appreciate the flavor of our home-grown products instead—which could stand comparison if we gave it a chance."

"That so?" the Rhean smiled.

"I notice you're smoking Earth-grown tobacco."

"A habit I can break if I have to."

"Probably by giving up smoking. I wouldn't use Outer World tobacco for anything but killing mosquitoes."

He laughed a trifle too boisterously, and left the group. Maynard stared after him, a little pinch-nosed.

To Keilin, the little byplay over rye and tobacco brought a certain satisfaction. He regarded such personalities as the tiny reflection of certain Galactopolitical realities. Tethys and Rhea were the largest planets in the Galactic south, as Aurora was the largest in the Galactic north. All three planets were identically racist, identically exclusivist. Their views on Earth were similar and completely compatible. Ordinarily, one would think that there was no room to quarrel.

But Aurora was the oldest of the Outer Worlds, the most advanced, the strongest militarily—and, therefore, aspired to a sort of moral leadership of all the Worlds. That was sufficient in itself to arouse opposition, and Rhea and Tethys served as focal points for those who did not recognize Auroran leadership.

Keilin was somberly grateful for that situation. If Earth could but lean her weight properly, first in one direction, then in the other, an ultimate split, or even fragmentation—

He eyed Maynard cautiously, almost furtively, and wondered what effect this would have on the next day's debate. Already, the Auroran was more silent than was quite polite.

And then some under-secretary or sub-official threaded his way through the clusters of guests in finicking fashion, and beckoned to Maynard.

Keilin's following eyes watched the Auroran retreat with the newcomer, watched him listen closely, mouth a startled "What!" that was quite visible to the eye, though too far off to be heard, and then reach for a paper that the other handed him.

And as a result the next day's session of the conference went entirely differently than Keilin would have predicted.

Keilin discovered the details in the evening video-casts. The Terrestrian government, it seemed, had sent a note to all the governments attending the conference. It warned each one bluntly that any agreement among them in military or economic affairs would be considered an unfriendly act against Earth and that it would be met with appropriate countermeasures. The note denounced Aurora, Tethys, and Rhea all equally. It accused them of being engaged in an imperialist conspiracy against Earth, and so on—and on—and on.

"Fools!" gritted Keilin, all but butting his head against the wall out of sheer chagrin. "Fools! Fools!

Fools!" And his voice died away still muttering that same one word.

The next session of the conference was well and early attended by a set of angry delegates who were only too eager to grind into nothingness the disagreements still outstanding. When it ended, all matters concerning trade between Earth and the Outer Worlds had been placed in the hands of a commission with plenary powers.

Not even Aurora could have expected so complete and easy a victory, and Keilin, on his way back to Earth, longed for his voice to reach the video, so that is could be to others, and not to himself only, that he could shout his disgust.

Yet on Earth, some men smiled.

Once back on Earth, the voice of Keilin slowly swirled under and down—lost in the noisier clamor that shouted for action.

His popularity sank in proportion as trade restrictions grew. Slowly, the Outer Worlds drew the noose tighter. First, they instituted a strict application of a new system of export licensing. Secondly, they banned the export to Earth of all materials capable of being "used in a war effort". And finally they applied a very broad interpretation indeed of what could be considered usable in such a connection.

Imported luxuries—and imported necessities, too, for that matter—vanished or priced themselves upwards out of the reach of all but the very few.

So the people marched, and the voices shouted and the banners swung about in the sunlight, and the stones flew at the consulates—

Keilin shouted hoarsely and felt as if he were going mad.

Until, suddenly, Luiz Moreno, quite of his own accord, offered to appear on Keilin's program and submit to unrestricted questioning in his capacity as ex-Ambassador to Aurora and present Secretary without Portfolio.

To Keilin it had all the possibilities of a rebirth. He knew Moreno—no fool, he. With Moreno on his program, he was assured an audience as great as his greatest. With Moreno answering questions, certain misapprehensions might be removed, certain confusions might be straightened. The mere fact that Moreno wished to use his—*his*—program as sounding board might well mean that already a more pliant and sensible foreign policy might have been decided upon. Perhaps Maynard was correct, and the pinch was being felt and was working as predicted.

The list of questions had, of course, been submitted to Moreno in advance, but the ex-Ambassador had indicated that he would answer all of them, and any follow-up questions that might seem necessary.

It seemed quite ideal. Too ideal, perhaps, but only a criminal fool could worry over minutiae at this point.

There was an adequate ballyhoo—and when they faced one another across the little table, the red needle that indicated the number of video sets drawing power on that channel hovered well over the two hundred million mark. And there was an average of 2.7 listeners per video set. Now the theme; the official introduction.

Keilin rubbed his cheek slowly, as he waited for the signal.

Then, he began:

Q. Secretary Moreno, the question which interests all Earth at the moment, concerns the possibility of war. Suppose we start with that. Do you think there will be war?

A. If Earth is the only planet to be considered, I say: No, definitely not. In its history, Earth has had too much war, and has learned many times over how little can be gained by it.

Q. You say, "If Earth is the only planet to be considered—" Do you imply that factors outside our control will bring war?

A. I do not say "will"; but I could say "may". I cannot, of course speak for the Outer Worlds. I cannot pretend to know their motivations and intentions at this critical moment in Galactic history. They *may* choose war. I hope not. If so be that they do, however, we will defend ourselves. But in any case, *we* will never attack; *we* will not strike the first blow.

Q. Am I right in saying, then, that in your opinion there are no basic differences between Earth and the Outer Worlds, which cannot be solved by negotiation?

A. You certainly are. If the Outer Worlds were sincerely desirous of a solution, no disagreement between them and us could long exist.

Q. Does that include the question of immigration?

A. Definitely. Our own role in the matter is clear and beyond reproach. As matters stand, two hundred million human beings now occupy ninety-five percent of the available land in the universe. Six billions—that is, ninety-seven percent of all mankind—are squeezed into the other five percent. Such a situation is obviously unjust and, worse, unstable. Yet Earth, in the face of such injustice, has always been willing to treat this problem as soluble by degrees. It is still so willing. We would agree to reasonable quotas and reasonable restrictions. Yet the Outer Worlds have refused to discuss this matter. Over a space of five decades, they have rebuffed all efforts on the part of Earth to open negotiations.

Q. If such an attitude on the part of the Outer Worlds continues, do you *then* think there will be war?

A. I cannot believe that this attitude will continue. Our government will not cease hoping that the Outer Worlds will eventually reconsider their stand on the matter; that their sense of justice and right is not dead, but only sleeping.

Q. Mr. Secretary, let us pass on to another subject. Do you think that the United Worlds Commission set up by the Outer Worlds recently to control trade with Earth represents a danger to peace?

A. In the sense that its actions indicate a desire on the part of the Outer Worlds to isolate Earth, and to weaken it economically, I can say that it does.

Q. To what actions do you refer, sir?

A. To its actions in restricting interstellar trade with Earth to the point where, in credit values, the total stands now at less than ten percent of what it did three months ago.

Q. But do such restrictions really represent an economic danger to Earth? For instance, is it not true that trade with the Outer Worlds represents an almost insignificant part of total Terrestrian trade? And is it not true that the importations from the Outer Worlds reach only a tiny minority of the population at best?

A. Your questions now are representative of a profound fallacy which is very common among our isolationists. In credit values, it is true that interstellar trade represents only five percent of our total trade, but ninety-five percent of our atomic engines are imported. Eighty percent or our thorium, sixty-five percent of our cesium, sixty percent of our molybdenum and tine are imported. The list can be extended almost indefinitely, and it is quite easy to see that the five percent is an extremely important, a vital, five percent. Furthermore, if a large manufacturer receives a shipment of atomic steel-shapers from Rhea, it does not follow that the benefit redounds only to him. Every man on Earth who uses steel implements or objects manufactured by steel implements benefits.

Q. But is it not true that the current restrictions on Earth's interstellar trade have cut our grain and cattle exports to almost nothing? And far from harming Earth, isn't this really a boon to our own hungry people?

A. This is another serious fallacy. That Earth's good food supply is tragically inadequate is true. The government would be the last to deny it. But our food exports do not represent any serious drain upon this supply. Less than one fifth of one percent of Earth's food is exported, and in return we obtain, for instance, fertilizers and farm machinery which more than make up for that small loss by increasing agricultural efficiency. Therefore, by buying less food from us, the Outer Worlds are engaged, in effect, in cutting our already inadequate food supply.

Q. Are you ready to admit, then, Secretary Moreno, that at least part of the blame for this situation should rest with Earth itself? In other words, we come to my next question: Was it not a diplomatic blunder of the first magnitude for the government to issue its inflammatory note denouncing the inten-

tions of the Outer Worlds before those intentions had been made clear at the Interplanetary Conference?

A. I think those intentions were quite clear at the time.

Q. I beg pardon, sir, but I was at the conference. At the time the note was issued, there was almost a stalemate among the Outer World delegates. Those of Rhea and Tethys strongly opposed economic action against Earth, and there was considerable chance that Aurora and its bloc might have been defeated. Earth's note ended that possibility instantly.

A. Well, what is your question, Mr. Keilin?

Q. In view of my statements, do you or do you not think Earth's note to have been a criminal error of diplomacy which can now be made up only by a policy of intelligent conciliation?

A. You use strong language. However, I cannot answer the question directly, since I do not agree with your major premise. I cannot believe that the delegates of the Outer Worlds could behave in the manner you describe. In the first place, it is well known that the Outer Worlds are proud of their boast that the percentage of insanity, psychoses, and even relatively minor maladjustments of personality are almost at the vanishing point in their society. It is one of their strongest arguments against Earth, that we have more psychiatrists than plumbers and yet are more pinched for want of the former. The delegates to the conference represented the best of this so-stable society. And now you would have me believe that these demigods would, in a moment of pique, have reversed their opinions and instituted a major change in the economic policy of fifty worlds. I cannot believe them capable of such childish and perverse activity, and must therefore insist than any action they took was based not upon any note from Earth, but upon motivations that go deeper.

Q. But I saw the effect upon them with my own eyes, sir. Remember, they were being scolded in what they considered to be insolent language from an inferior people. There can be no doubt, sir, that as a whole, the men of the Outer Worlds are a remarkably stable people, despite your sarcasm, but their attitude towards Earth represents a weak point in this stability.

A. Are you asking me questions, or are you defending the racist views and policies of the Outer Worlds?

Q. Well, accepting your viewpoint that Earth's note did no harm, what good could it have done? Why should it have been sent?

A. I think we were justified in presenting our side of the question before the bar of Galactic public opinion. I believe we have exhausted the subject. What is your next question, please? It is the last, isn't it?

Q. It is. It has recently been reported that the Terrestrian government will take stern measures

against those dealing in smuggling operations. Is this consistent with the government's view that lowered trade relations are detrimental to Earth's welfare?

A. Our primary concern is peace, and not our own immediate welfare. The Outer Worlds have adopted certain trade restrictions. We disapprove of them, and consider them a great injustice. Nevertheless, we shall adhere to them, so that no planet may say that we have given the slightest pretext for hostilities. For instance, I am privileged to announce here for the first time that in the past month, five ships, traveling under false Earth registry, were stopped while being engaged in the smuggling of Outer World materiel into Earth. Their goods were confiscated and their personnel imprisoned. This is an earnest of our good intentions.

Q. Outer World ships?

A. Yes. But traveling under false Earth registry, remember.

Q. And the men imprisoned are citizens of the Outer Worlds?

A. I believe so. However, they were breaking not only our laws, but those of the Outer Worlds as well, and therefore doubly forfeited their interplanetary rights. I think the interview had better close, now.

Q. But this—

It was at this point that the broadcast came to a sudden end. The conclusion of Keilin's last sentence was never heard by anyone but Moreno. It ended like this:

"—means war."

But Luis Moreno was no longer on the air. So as he drew on his gloves, he smiled and, with infinite meaning, shrugged his shoulders in a little gesture of indifference.

There were no witnesses to that shrug.

The Gathering at Aurora was still in session. Franklin Maynard had dropped out for the moment in utter weariness. He faced his son whom he now saw for the first time in naval uniform.

"At least *you're* sure of what will happen, aren't you?"

In the young man's response, there was no weariness at all, no apprehension; nothing but utter satisfaction. "This is it, dad!"

"Nothing bothers you, then? You don't think we've been maneuvered into this."

"Who cares if we have? It's Earth's funeral."

Maynard shook his head: "But you realize that we've been put in the wrong. The Outer World citizens they hold are law-breakers. Earth is within its rights."

His son frowned: "I hope you're not going to make statements like that to the Gathering, dad. I don't see that Earth is justified at all. All right, what if smuggling was going on. It was just because some Outer Worlders are willing to pay black market prices for Terrestrial food. If Earth had any sense, she could look the other way, and everyone would benefit. She makes

enough noise about how she needs our trade, so why doesn't she do something about it. Anyway, I don't see that we ought to leave any good Aurorans or other Outer Worlders in the hands of those apemen. Since they won't give them up, we'll make them. Otherwise, none of us will be safe next time."

"I see that you've adopted the popular opinions, anyway."

"The opinions are my own. If they're popular opinion also, it's because they make sense. Earth *wants* a war. Well, they'll get it."

"But why do they want a war, eh? Why do they force our hands? Our entire economic policy of the past months was only intended to force a change in their attitude without war."

He was talking to himself, but his son answered with the final argument: "I don't care why they wanted war. They've *got* it now, and we're going to smash them."

Maynard returned to the Gathering, but even as the drone of debate re-filled the room, he thought, with a twinge that there would be no Terrestrian alfalfa that year. He regretted the milk. In fact, even the beef seemed, somehow, to be just a little less savory—

The vote came in the early hours of the morning. Aurora declared war. Most of the worlds of the Aurora bloc joined it by dawn.

In the history books, the war was later known as the Three Weeks' War. In the first week, Auroran forces occupied several of the trans-Plutonian asteroids, and at the beginning of the third week, the bulk of Earth's home fleet was all but completely destroyed in a battle within the orbit of Saturn by an Aurora fleet not one-quarter its size, numerically.

Declarations of war from the Outer Worlds yet neutral followed like the *pop-pop* of a string of firecrackers.

On the twenty-first day of the war, lacking two hours, Earth surrendered.

The negotiations of peace terms took place among the Outer Worlds. Earth's activities were concerned with signing only. The conditions of peace were unusual, perhaps unique, and under the force of an unprecedented humiliation, all the hordes of Earth seemed suddenly struck with a silence that came from a shamed anger too strong for words.

The terms mentioned were perhaps best commented upon by a voice on the Auroran video two days after they were made public. It can be quoted in part:

". . . There is nothing in or on Earth that we of the Outer Worlds can need or want. All that was ever worthwhile on Earth left it centuries ago in the persons of our ancestors.

"They call us the children of Mother Earth, but that is not so, for we are the decendents of a

Mother Earth that no longer exists, a Mother Earth that we brought with us. The Earth of today bears us at best a cousinly relation. No more.

"Do we want their resources? Why, they have none for themselves. Can we use their industry or science? They are almost dead for lack of ours. Can we use their man power? Ten of them are not worth a single robot. Do we even want the dubious glory of ruling them? There is no such glory. As our helpless and incompetent inferiors, they would be only a drag upon us. They would divert from our own use food, labor, and administrative ability.

"So they have nothing to give us, but the space they occupy in our thought. They have nothing to free us from, but themselves. They cannot benefit us in any way other than in their absence.

"It is for that reason, that the peace terms have been defined as they have been. We wish them no harm, so let them have their own solar system. Let them live there in peace. Let them mold their own destiny in their own way, and we will not disturb them there by even the least hint of our presence. But we in turn want peace. We in turn would guide our own future in our own way. So we do not want *their* presence. And with that end in view, an Outer World fleet will patrol the boundaries of their system, Outer World bases will be established on their outermost asteroids,

so that we may make sure they do not intrude on our territory.

"There will be no trade, no diplomatic relationships, no travel, no communications. They are fenced off, locked out, hermetically sealed away. Out here we have a new universe, a second creation of Man, a higher Man—

"They ask us: What will become of Earth? We answer: That is Earth's problem. Population growth can be controlled. Resources can be efficiently exploited. Economic systems can be revised. We know, for we have done so. If they cannot, let them go the way of the dinosaur, and make room.

"Let them make room, instead of forever demanding room!"

And so an impenetrable curtain swung slowly shut about the Solar System. The stars in Earth's sky became only stars again as in the long-dead days before the first ship had penetrated the barrier of light's speed.

The government that had made war and peace resigned, but there was no one really to take their place. The legislature elected Luiz Moreno —ex-Ambassador to Aurora, ex-Secretary without Portfolio—as President *pro tem,* and Earth as a whole was too numbed to agree or disagree. Their was only a widespread relief that someone existed who would be willing to take the job of trying to guide the destinies of a world in prison.

Very few realized how well-planned an ending this was, or with what calculation, Moreno found himself in the president's chair.

Ernest Keilin said hopelessly from the video screen: "We are only ourselves now. For us, their is no universe and no past—only Earth, and the future."

That night he heard from Luiz Moreno once again, and before morning he left for the capital.

Moreno's presence seemed incongruent within the stiffly formal president's mansion. He was suffering from a cold again, and snuffled when he talked.

Keilin regarded him with a self-terrifying hostility; an almost singing hatred in which he could feel his fingers begin to twitch in the first gestures of choking. Perhaps he shouldn't have come— Well, what was the difference; the orders had been plain. If he had not come, he would have been brought.

The new president looked at him sharply: "You will have to alter your attitude toward me, Keilin. I know you regard me as one of the Gravediggers of Earth—isn't that the phrase you used last night?—but you must listen to me quietly for a while. In your present state of suppressed rage, I doubt if you could hear me."

"I will hear whatever you have to say, Mr. President."

"Well—the external amenities, at least. That's hopeful. Or do you

think a video-tracer is attached to the room?"

Keilin merely lifted his eyebrows.

Moreno said: "It isn't. We are quite alone. We *must* be alone, otherwise how could I tell you safely that it is being arranged for you to be elected president under a constitution now being devised. Eh, what's the matter?"

Then he grinned at the look of bloodless amazement in Keilin's face. "Oh, you don't believe it. Well, it's past your stopping. And before an hour is up, you'll understand."

"I'm to be president?" Keilin struggled with a strange, hoarse voice. Then, more firmly: "You are mad."

"No. Not I. Those out there, rather. Out there in the Outer Worlds." There was a sudden vicious intensity in Moreno's eyes, and face, and voice, so that you forgot he was a little monkey of a man with a perpetual cold. You didn't notice the wrinkled sloping forehead. You forgot the baldish head and ill-fitting clothes. There was only the bright and luminous look in his eyes, and the hard incision in his voice. *That* you noticed.

Keilin reached blindly backward for a chair, as Moreno came closer and spoke with increasing intensity.

"Yes," said Moreno. "Those out among the Stars. The godlike ones. The stately supermen. The strong, handsome master-race. *They* are mad. But only we on Earth know it.

"Come, you have heard of the Pacific Project. I know you have. You denounced it to Cellioni once, and called it a fake. But it isn't a fake. And almost none of it is a secret. In fact, the only secret about it was that almost none of it was a secret.

"You're no fool, Keilin. You just never stopped to work it all out. And yet you were on the track. You had the feel of it. What was it you said that time you were interviewing me on the program? Something about the attitude of the Outer Worldling toward the Earthman being the only flaw in the former's stability. That was it, wasn't it? Or something like that? Very well, then; good! You had the first third of the Pacific Project in your mind at the time, and it was no secret after all, was it?

"Ask yourself, Keilin—what was the attitude of the typical Auroran to a typical Earthman? A feeling of superiority? That's the first thought, I suppose. But, tell me, Keilin, if he really felt superior, *really* superior, would it be so necessary for him to call such continuous attention to it. What kind of superiority is it that must be continuously bolstered by the constant repetition of phrases such as 'apemen,' 'sub-men,' 'half-animals of Earth,' and so on? That is not the calm internal assurance of superiority. Do you waste epithets on earthworms? No, there is something else there.

"Or let us approach it from an-

other tack. Why do Outer World tourists stay in special hotels, travel in inclosed ground-cars, and have rigid, if unwritten, rules against social intermingling? Are they afraid of pollution? Strange then that they are not afraid to eat our food and drink our wine and smoke our tobacco.

"You see, Keilin, there are no psychiatrists on the Outer Worlds. The supermen are, so they say, too well adjusted. But here on Earth, as the proverb goes, there are more psychiatrists than plumbers, and they get lots of practice. So it is we, and not they, who know the truth about this Outer World superiority-complex; who know it to be simply a wild reaction against an overwhelming feeling of *guilt.*

"Don't you think that can be so? You shake your head as though you disagree. You don't see that a handful of men who clutch a Galaxy while billions starve for lack of room *must* feel a subconscious guilt, no matter what? And, since they won't share the loot, don't you see that the only way they can justify themselves is to try to convince themselves that Earthmen, after all, are inferior, that they do not deserve the Galaxy, that a new race of men have been created out there and that we here are only the diseased remnants of an old race that should die out like the dinosaur, through the working of inexorable natural laws.

"Ah, if they could only convince themselves of that, they would no longer be guilty, but merely superior. Only it doesn't work; it never does. It requires constant bolstering; constant repetition, constant reinforcement. And still it doesn't quite convince.

"Best of all, if only they could pretend that Earth and its population do not exist at all. When you visit Earth, therefore, avoid Earthmen; or they might make you uncomfortable by not looking inferior enough. Sometimes they might look miserable instead, and nothing more. Or worse still, they might even seem intelligent—as I did, for instance, on Aurora.

"Occasionally, an Outer Worlder like Moreanu did crop up, and was able to recognize guilt for what it was without being afraid to say so out loud. He spoke of the duty the Outer Worlds owed Earth—and so he was dangerous to us. For if the others listened to him and had offered token assistance to Earth, their guilt might have been assuaged in their own minds; and that without any lasting help to Earth. So Moreanu was removed through our web-weaving, and the way left clear to those who were unbending, who refused to admit guilt, and whose reaction could therefore be predicted and manipulated.

"Send them an arrogant note, for instance, and they automatically strike back with a useless embargo that merely gives us the ideal pretext for war. Then lose a war quickly, and you are sealed off by the annoyed supermen. No communica-

tion, no contact. You no longer exist to annoy them. Isn't that simple? Didn't it work out nicely?"

Keilin finally found his voice, because Moreno gave him time by stopping. He said: "You mean that all this was planned? You *did* deliberately instigate the war for the purpose of sealing Earth off from the Galaxy? You sent out the men of the Home Fleet to sure death because you wanted defeat? Why, you're a monster, a . . . a—"

Moreno frowned: "Please relax. It was not as simple as you think, and I am not a monster. Do you think the war could simply be—instigated? It had to be nurtured gently in just the right way and to just the right conclusion. If we had made the first move; if we had been the aggressor; if we had in any way put the fault on our side—why they of the Outer Worlds would have occupied Earth, and ground it under. They would no longer feel guilty, you see, if *we* committed a crime against *them*. Or, again, if we fought a protracted war, or one in which we inflicted damage, they could succeed in shifting the blame.

"But we didn't. We merely imprisoned Auroran smugglers, and were obviously within our rights. They had to go to war over it because only so could they protect their superiority which in turn protected them against the horrors of guilt. And we lost quickly. Scarcely an Auroran died. The guilt grew deeper and resulted in exactly the peace treaty our psychiatrists had predicted.

"And as for sending men out to die, that is a commonplace in every war—and a necessity. It was necessary to fight a battle, and, naturally, there were casualties."

"But why?" interrupted Keilin, wildly. "Why? *Why?* Why does all this gibberish seem to make sense to you? What have we gained? What can we possibly gain out of the present situation?"

"Gained, man? You ask what we've gained? Why, we've gained the universe. What has held us back so far? *You* know what Earth has needed these last centuries. You yourself once outlined it forcefully to Cellioni. We need a positronic robot society and an atomic power technology. We need chemical farming and we need population control. Well, what's prevented that, eh? Only the customs of centuries which said robots were evil since they deprived human beings of jobs, that population control was merely the murder of unborn children, and so on. And worse, there was always the safety valve of emigration either actual or hoped-for.

"But now we cannot emigrate. We're *stuck* here. Worse than that, we have been humiliatingly defeated by a handful of men out in the stars, and we've had a humiliating treaty of peace forced upon us. What Earthman wouldn't subconsciously burn for revenge, and what human motivation is stronger than the desire for revenge. Self-preservation

has frequently knuckled under to that tremendous yearning to 'get even'.

"And that is the second third of the Pacific Project, the recognition of the revenge motive. As simple as that.

"And how can we know that this is really so? Why, it has been demonstrated in history scores of times. Defeat a nation, but don't crush it entirely, and in a generation or two or three it will be stronger than it was before. Why? Because in the interval, sacrifices will have been made for revenge that would not have been made for mere conquest.

"Think! Rome beat Carthage rather easily the first time, but was almost defeated the second. Every time Napoleon defeated the European coalition, he laid the groundwork for another just a little bit harder to defeat, until he himself was crushed by the eighth. It took four years to defeat Wilhelm of medieval Germany, and six much more dangerous years to stop his successor, Hitler.

"There you are! Until now, Earth needed to change its way of life only for greater comfort and happiness. A minor item like that could always wait. But now it must change for revenge and that will not wait. And I want that change for its own sake.

"Only—I am not the man to lead. I am tarred with the failure of yesteryear, and will remain so until, long after I am bone-dust, Earth learns the truth. But you . . . *you*, and others like you, have always fought for the road to modernization. *You* will be in charge. It may take a hundred years. Grandchildren of men unborn may be the first to see its completion. But at least you will see the start.

"Eh, what do you say?"

Keilin was fumbling at the dream. He seemed to see it in a misty distance—a new and reborn Earth. But the change in attitude was too extreme. It could not be done just yet. He shook his head.

He said: "What makes you think the Outer Worlds would allow such a change, supposing what you say to be true. They will be watching, I am sure, and they will detect a growing danger and put a stop to it. Can you deny that?"

Moreno threw his head back and laughed noiselessly. He gasped out: "But we have still a third left of the Pacific Project, a last, subtle and ironic third—

"The Outer Worlders call the men of Earth the subhuman dregs of a great race, but *we* are the men of *Earth*. Do you realize what that means? We live on a planet upon which for a billion years, life—the life that has culminated in Mankind—has been adapting itself. There is not a microscopic part of Man, not a tiny working of his mind, that has not as its reason some tiny facet of the physical make-up of Earth, or of the biological make-up of Earth's other life-forms, or of the

sociological make-up of the society about him.

"No other planet can substitute for Earth, *in Man's present shape.*

"The Outer Worlders exist as they do, only because pieces of Earth have been transplanted. Soil has been brought out there; plants; animals; men. They keep themselves surrounded by an artificial Earth-born geology which has within it, for instance, those traces of cobalt, zinc, and copper which human chemistry must have. They surround themselves by Earth-born bacteria and algae which have the ability to make those inorganic traces available in just the right way and in just the right quantity.

"And they maintain that situation by continued imports—luxury imports, they call it—from Earth.

"But on the Outer Worlds, even with Terrestrian soil laid down to bedrock, they cannot keep rain from falling and rivers from flowing, so that there is an inevitable, if slow, admixture with the native soil; an inevitable contamination of Terrestrian soil bacteria with the native bacteria, and an exposure, in any case, to a different atmosphere and to solar radiations of different types. Terrestrian bacteria disappear or change. And then plant life changes. And then animal life.

"No great change, mind you. Plant life would not become poisonous or nonnutritious in a day, or year, or decade. But already, the men of the Outer Worlds can detect the loss or change of the trace compounds that are responsible for that infinitely elusive thing we call 'flavor.' It has gone that far.

"And it will go further. Do you know, for instance, that on Aurora, nearly one half the native bacterial species known have protoplasm based on a fluorocarbon rather than hydrocarbon chemistry. Can you imagine the essential foreignness of such an environment?

"Well, for two decades now, the bacteriologists and physiologists of Earth have studied various forms of Outer World life—the only portion of the Pacific Project that has been truly secret—and the transplanted Terrestrian life is already beginning to show certain changes on the subcellular level. *Even among the humans.*

"And here is the irony. The Outer Worlders, by their rigid racism and unbending genetic policies are consistently eliminating from among themselves any children that show signs of adapting themselves to their respective planets in any way that departs from the norm. They are maintaining—they *must* maintain as a result of their own thought-processes—an artificial criterion of 'healthy' humanity, which is based on Terrestrian chemistry and not their own.

"But now that Earth has been cut off from them; now that not even a trickle of Terrestrian soil and life will reach them, change will be piled on change. Sicknesses will come, mortality will increase, child

abnormalities will become more frequent—"

"And then?" asked Keilin, suddenly caught up.

"And then? Well, they are physical scientists—leaving such inferior sciences as biology to us. And they cannot abandon their sensation of superiority and their arbitrary standard of human perfection. They will never detect the change till it is too late to fight it. Not all mutations are clearly visible, and there will be an increasing revolt against the mores of those stiff Outer World societies. There will be a century of increasing physical and social turmoil which will prevent any interference on their part with us.

"We will have a century of rebuilding and revitalization, and at the end of it, we shall face an outer Galaxy which will either be dying or changed. In the first case, we will build a second Terrestrian Empire, more wisely and with greater knowledge than we did the first; one based on a strong and modernized Earth.

"In the second case, we will face perhaps ten, twenty, or even all fifty Outer Worlds, each with a slightly different variety of Man. Fifty humanoid species, no longer united against us, each increasingly adapted to its own planet, each with a sufficient tendency toward atavism to love Earth, to regard it as the great and original Mother.

"And racism will be dead, for variety will then be the great fact of Humanity, and not uniformity. Each type of Man will have a world of its own, for which no other world could quite substitute, and on which no other type could live quite as well. And other worlds can be settled to breed still newer varieties, until out of the grand intellectual mixture, Mother Earth will finally have given birth not to merely a Terrestrian, but to a *Galactic* Empire."

Keilin said, fascinated: "You foresee all this so certainly."

"Nothing is *truly* certain; but the best minds on Earth agree on this. There may be unforeseen stumbling blocks on the way, but to remove those will be the adventure of our great-grandchildren. Of *our* adventure, one phase has been successfully concluded; and another phase is beginning. Join us, Keilin."

Slowly, Keilin began to think that perhaps Moreno was not a monster after all—

But for a century, the historians of Earth called the Three Weeks' War a defeat.

THE END

ELECTRICAL MATHEMATICIANS

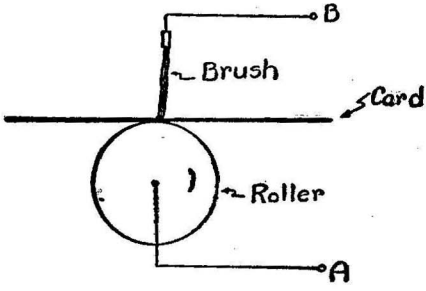
BY LORNE MACLAUGHLAN

To an extent none of us today can realize, these rapidly growing electrical calculators will become more and more important factors in ordinary life. So far, they are handling only simple, straight-arithmetic problems. They are brains, but so far they think only on low levels. Give them time; they will be planners yet!

In this machine age no one is surprised at the announcement of some new or improved labor-saving device. The scientists and technologists who design our new electronic rattraps, microwave hot-dog dispensers and atomic power plants have succeeded so well that they have created a serious manpower shortage in their own professions. This shortage, which is chiefly in the field of analysis has recently forced them to put an unprecedented amount of effort into the design of machines to save themselves mental labor. The results of their efforts are an amazingly variegated collection of computing machines, or "artificial brains" as they are called in the popular press.

The development of such machines took a tremendous spurt during the war, and today we can scarcely find a laboratory or university in the land which is not devoting some part of its efforts to work of this kind. Progress is so rapid that the machines are obsolete before they are completed, and thus no two identical machines exist.

We cannot say that the computing machine is a new invention—the unknown Chinese originator of the abacus provided man with his first calculating machine in the sixth century B.C. This would seem to make the machine nearly as old as the art of calculating, but man is equipped with fingers and toes which have always provided a handy portable computing device. In fact, as we shall see, the simple fact that we have ten fingers has a definite bearing on the number of tubes and the



The basic mechanism in the punched-card machine is the brush and roller combination shown. As the card passes over a steel roller, metallic brushes make an electrical connection—between A and B in the diagram—and a signal can be produced to reject the card, or set a counter wheel, et cetera.

kind of circuits required in electronic digital computers.

It should be pointed out that there are two distinct types of computing machines in common use today. One type deals with discrete whole numbers, counting them off with the aid of teeth on a wheel, or electrical pulses in vacuum tube circuits. These numbers represent quantities, and they are added and multiplied just as numbers are on paper, but at a much higher speed. These machines called digital computers, range from the simple cash-register adding machine to the complex all-electric ENIAC, with its eighteen thousand radio-type vacuum tubes.

The other type of machine is the analogue type of computer, in which the number to be dealt with is converted into some measurable quantity, such as length along a slide rule, or angle of rotation of a shaft. The operations are performed electrically or mechanically, and the answer appears as a length, an angle, a voltage or some other quantity which must be converted back to a number. The ideal machine of the analogue type will accept mathematical functions, empirical curves, and directions for mixing and stirring, and turn out results in the form of curves automatically.

The digital computer is much more accurate than the analogue type for the simple reason that it is easy to extend the number of significant digits in such machines to something like thirty or forty. It is impossible to measure a point on a curve to anything approaching one part in 10^{40}. However, the analogue computers are in many ways faster and more versatile, because they can perform certain difficult mathematical operations directly, while digital machines require that these operations be reduced to addition and multiplication.

One of the first things we must do to understand modern digital computing machines is to disconnect our minds from the decimal number system, and get a more basic concept of number representation. The decimal system of numbers is a natural choice, based on the fact that

man has ten fingers. We would perhaps be more fortunate had evolution given us twelve, for then our number system would be the more convenient duo-decimal system. Let us examine this system as a starting point, by studying the table of numbers below.

1	2	3	4	5	6	7	8	9	*	†	10
11	12	13	14	15	16	17	18	19	1*	1†	20
21	22	23	24	25	26	27	28	29	2*	2†	30

The six-fingered man would count to six on one hand, and then continue, seven, eight, nine, star, dagger, ten on the other. His ten would be our twelve, of course, but it would be a resting point for him while he got his shoes off to continue to his twenty—our twenty-four—on his twelve toes.

If we continue the table for twelve lines of twelve numbers each we will get to his one hundred, which corresponds to our one hundred forty-four. This number is his ten squared—our twelve squared—as it should be, and is preceded by his daggerty-dagger, ††. This duo-decimal system has the advantage that ten can be divided by 2, 3, 4 and 6, giving in each case whole numbers —$10/4 = 3$, $10/6 = 2$, et cetera —while our ten is only divisible by 2 and 5. The ancient Babylonians were fond of this system, and also used sixty as a number base. These systems remain, today as the bases of our measurement of time in seconds, minutes and hours.

Now let us examine the binary system, based on two. In this system all numbers are made up of combinations of just two digits, one and zero. The simplicity of this system makes it possible to use simple devices such as electromagnetic relays to represent numbers. The simple relay has two possible positions, open and closed, and we can represent zero by means of the open position, and one by the closed position, and then build up any number as shown in the table below.

Decimal System	Binary System
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010

Computation is easy with this system, once we get the hang of it. Thus our two cubed becomes, $10^{11} = 10 \times 10 \times 10 = 1000$, and our two times three becomes $10 \times 11 = 110$, which is our six, as it should be.

With our minds cleared for action on any number base let us consider the capabilities which are necessary in a digital computer. Digital computation requires that all operations be reduced to those of addition, subtraction, multiplication and division whether a machine is used or not. These operations involve certain

reflex actions, such as the response "six" when presented with the numbers "two" and "three" and the idea "multiply." The trained human mind possesses such reflex actions, and the machine must also possess them, as a first requirement. Simple computing devices such as the commercial accounting machine possess a few reflexes. It is necessary to build many rapid reflexes into mathematical computing machines.

The next "mental" capability the machine must possess is that of memory. When we must multiply two numbers together before adding them to a third, memory is needed to preserve the product until the second operation can be performed. Commercial calculating machines have limited memory—after multiplication, for example, the number appears on the output wheels, and the third number can easily be added. The memory requirements in a good mathematical machine are much, much more stringent, and provide some of the toughest problems in design. Not only must we "teach" the machine the multiplication table —by the process of wiring in the right connections –but it may also be necessary to provide built-in tables of sine and cosine functions, as well as other commonly used functions. This is a permanent kind of memory—a fast temporary kind of memory is also needed to remember such things as the product referred to above until it is no longer needed. This memory has not been easy to provide in required amounts, but recently invented electronic devices seem to offer some hope that this difficulty can be overcome.

There are still two important capabilities left. These are choice and sequence. The computing machine should be able to choose between two numbers, or two operations it can perform, in accordance with certain rules. Sequence involves, as the name implies, the proper choice of order of numbers or operations according to some rule which applies in the particular problem being solved.

These last two capabilities are not found to any great extent in any but the most modern mathematical computing machines. On the other hand there are a multitude of other mental capabilities found in humans which are undesirable in mathematical machines. Emotion, aesthetics, creative ability and so forth are not desirable, for these help to make humans unfit for much routine computing work. What we want is a perfect slave, fast, untiring and industrious, who will never embarrass or disconcert us with unexpected response. (Of course the engineers in charge of some of the complicated modern mathematical machines are quick to accuse them of temper tantrums and other undesirable emotions.)

Perhaps the fanciest digital computing machine today is the IBM Automatic Sequence Controlled Calculator at Harvard. The letters

IBM refer to the International Business Machines Corporation, which has developed a series of machines primarily intended for use in accounting work. These machines use a punched card—a device with quite a history, as histories go in the computing field. It seems that weaving machines which could be used to more or less automatically weave patterned cloth excited the imagination of a good many inventors in France in the early eighteenth century. In such weaving it was necessary to sequence automatically the "shedding," or controlling of the warp threads so that weft threads could be passed through them to weave a pattern. Punched tape and punched cards had already been used by 1727. The punched cards we use today get the name Jacquard cards from the name of the inventor of an improved weaving machine around the year 1800.

This basic idea was good enough to attract the attention of Charles Babbage, an English actuary, who is regarded as the father of the modern computing machine. His "difference engine" was designed, in his words, "to perform the whole operation"—of the computing and printing of tables of functions—"with no mental attention when numbers have once been placed in the machine." When this "engine" was nearly complete the government withdrew its support of the project, and Babbage began the construction of an analytical machine on his own. This machine, a wholly mechanical device, was to use punched Jacquard cards for automatic sequencing. In 1906 his son successfully completed a machine with which he calculated pi to twenty-nine significant figures.

Hollerith, in this country, made a great advance in the use of punched cards when he invented a card sorter to aid in classifying the results of the 1880 census. Most people today are familiar with the kind of things that a sorter can do. Thus if we have a sorter and a stack of cards with personal and alphabetical information punched thereon we can request the machine to pick out all left-handed individuals with cross-eyes and Z for a second initial, and bzzzzt, bzzzzt, bzzzzt—there they are.

The IBM Company, by catering to the needs of organizations which handle—and have—a good deal of money, was able to put the manufacture of computing machines on a paying basis. It need not be pointed out that it is much more difficult to produce profitably machines which will only be used for such tasks as the calculation of pi to umpteen places. However the punched card machines built for accountants have found their way into scientific computing laboratories, and the IBM Company has a research laboratory which is actively developing new machines for scientific use as well as for accounting.

A punched card machine operating on the Hollerith principle in-

terprets numerical and operational data according to the positions of holes punched on cards, and then perform various mathematical operations. The cards, which are familiar to most people—postal notes, government checks, et cetera—have twelve vertical positions in each of eighty columns. The vertical positions are labeled y, x, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. Thus an 80 digit or two 40 digit numbers can be set up on one card, and the y space, for example, may be used to indicate sign.

The cards are read for purposes of sorting-et cetera by a simple mechanism involving a metal cylinder and sets of electrically conducting brushes. As the card moves between the rotating cylinder and the eighty brushes, one for each column, an electrical contact is made whenever a punched hole passes under a brush. The position of the cylinder at the time that the brush makes contact indicates the number, or letter, represented. Any number system could be used, but the decimal system is selected because of its familiarity. The various IBM machines now on the market include Card Punchers, Card Interpretaters, Card Sorters, Collators and others, all operating on the same basic principles. The most useful machine to scientific workers is the Automatic Multiplying Punch. This machine will multiply factors punched in cards, and will automatically punch the product in a card, or even add and punch out products.

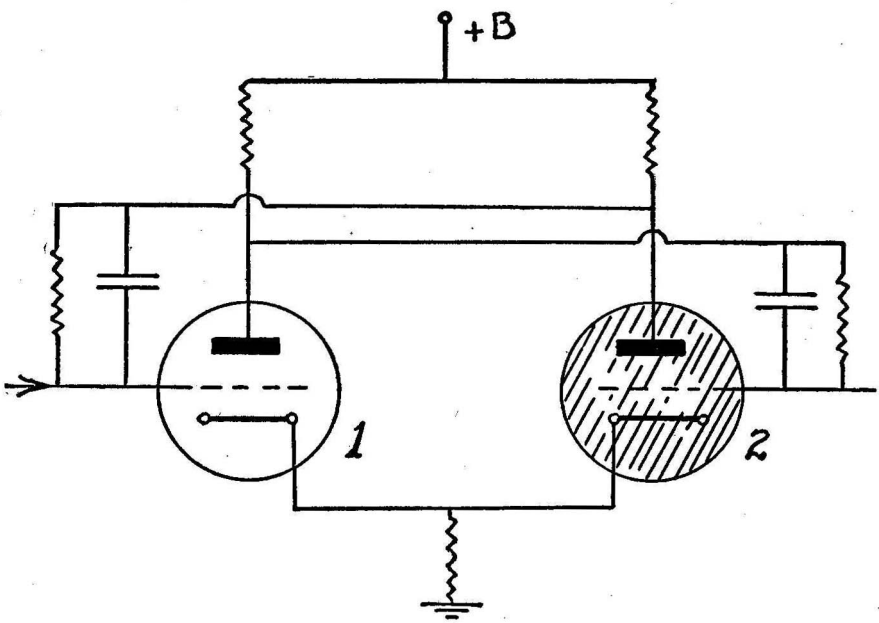
The computer lab at Harvard, mentioned above, uses a combination of these machines and a device for sequencing their operations—whence the name IBM Automatic Sequence Controlled Calculator. This calculator is one of the half-dozen large machines in this country which can be used to tear into a tough problem and quickly reduce it to a neat column of figures—or stack of cards, in this case. Since it is a digital type of computer it is capable of great accuracy, but because it is partly mechanical in operation it is slow compared to the newer all electronic machines. The automatic sequencing apparatus is not easy to set up, and thus this type of machine is best suited to the solution of repetitive types of problems, such as the calculation of tables. The punched card is a convenient form in which to store tables of simple functions, e.g. Sin x, Log x, which are often needed in the computation of tables of more complicated functions.

Of course, if you want to prepare a table umpteen places Bessell Functions, or evaluate some determinants, or make some matrix algebra manipulations you will have to wait some time for your turn on this or any similar machine. You will have to have a pretty good story too, for these machines are at work every day, and sometimes night as well with important problems. It must be realized too, that a problem must be rather important and complex before it is even worthwhile to go

to the labor of setting it up for solution in such a complicated machine.

Punched cards are often used to store scientific data other than tables with the advantages of machine sorting et cetera possible with IBM machines. Thus at the Caltech wind tunnel data from instruments is punched directly on cards. Astronomers locate star images by precomputed co-ordinates on punched cards, and then measure the star positions accurately and record the new information on new cards. The Census Bureau makes a great deal of use of punched cards at present, but plans are being made to go over to the faster electronic computers for this work.

Shortly before the war, G. R. Stibitz and others at the Bell Telephone Laboratories developed a re-



Basic flip-flop vacuum-tube circuit used in the ENIAC and in other digital computers. Tube number 2—shaded—is conducting, and tube number 1 is "cut-off," in the diagram above. A positive pulse on tube 1 will cause it to conduct and the resultant drop in its plate voltage will cause tube 2 to cease conducting. This condition is stable until another pulse arrives, on the grid of tube 2.

lay type of computer which could handle not only real numbers but complex numbers as well. The binary number system is convenient in a relay computer as we have pointed out. There is some difficulty entailed in the process of getting from a number expressed in the ordinary decimal system to the binary system and back again. For this reason Stibitz likes what he calls a bi-quinary system, which uses base 2 to tell if a number is between 0 and 4, or 5 and 9, and base 5 to tell which digit it is of the five. Early in the war the Army and Navy each ordered one of these relay computers, and machine computation was off to a flying start.

Dr. H. H. Aiken, who had built the IBM computer at Harvard has recently gone over to the relay type of computer, and his "Mark II" will soon be in operation on the complicated guided missile ballistics problems being studied at the Dahlgren Proving Ground. IBM has also been playing around with relay computers, and has delivered two sequence controlled machines of this type for ballistic research workers. Aiken does his sequencing with standard teletype tape, while some of the IBM jobs use plugboards.

An interesting example of a similar parallel development is the Zuse computer, named after its designer Conrad Zuse, who developed his machine in Germany during and since the war. Like the Bell Laboratories machine it uses a keyboard to feed numbers into its relays. The sequence is prepared in advance by an operator who punches instructions into a strip of film.

The art of machine computation took a tremendous jump ahead when in the fall of 1946 the ENIAC, the first electronic digital machine, was placed in operation. This machine was built for Army Ordnance at the Moore School of Engineering by J. W. Mauchly, J. P. Eckert and others. The ENIAC—Electronic Numerical Integrator and Calculator —with its eighteen thousand tubes is over a thousand times faster than the relay machines, which in turn were twelve times faster than the original punched card machine at Harvard. This tremendous increase in speed is the result of shifting over from the use of one gram relay armatures to the use of 10^{-31} gram electrons as moving parts. Of course a number of new problems appeared when this one limitation was removed. They are being cleared up one by one, chiefly by electronic means.

The ENIAC, despite the light weight of its moving parts, is no vest-pocket machine, as the number of vacuum tubes would indicate. The filaments of these tubes alone require eighty kilowatts of power, and a special blower system is needed to take away the heat. The whole machine occupies a space about 100 feet by 10 feet by 3 feet. Tube failures were a source of a good deal of trouble, because for a while at least one of the eighteen

thousand tubes burned out each time the power was turned on. This trouble was reduced by leaving the filaments of the tubes on, night and day, to eliminate the shocks involved in heating and cooling, so that now the ENIAC burn-outs at only about one per day, which take on the average only fifteen minutes to repair. Experience with this machine has aided the design of a series of successors, such as the EDVAC, the UNIVAC, and the MANIAC—inevitable name.

The most important type of unit in the ENIAC is a device which uses two triode tubes, called a flip-flop circuit. These tubes will do electrically what the relay does mechanically. Normally one of the two tubes in conducting current, and the other is "cut off." A very short—0.000001 seconds long—pulse of voltage can cause this tube to cut off or cease to conduct, and the other to begin to conduct. Since only these two stable states are possible, we have the beginning of a binary computer. We must add a small neon bulb to indicate when the second tube is conducting, and then add as many such units in series as there are binary digits in the number we wish to handle. These circuits are used as a fast memory device. The ENIAC has a fast memory of only twenty ten-digit numbers, a serious limitation which can only be overcome by adding to the already large number of tubes, or by going to other types of fast memory.

Adding is accomplished by connecting flip-flop circuits in tandem so that they can count series of electrical pulses. This counting works in the same way that the mileage indicator works in a car, except that the scale of two is used. Thus, suppose that initially all our flip-flop circuits are in one condition —call it flip. The first pulse causes the first circuit to go from flip to flop. The next one will return it to flip, and this causes the first circuit to emit a pulse which sends the second circuit to flop. This continues on throughout the chain of circuits, all connected in tandem, as long as pulses are fed into the first circuit. When two series of pulses have been fed in we can get our number by noting which circuits are on flip—binary zero—and which on flop—binary one. The result may be converted back to pulses for use elsewhere. The speed per digit in the adding operation is a comfortably short ten microseconds.

The description of the adding scheme above has omitted one added complication in circuit design which gives a considerable simplification in reading of numbers. The binary system is used to count only to ten in the ENIAC and the number is then converted to a decimal number. This is a bit of a nuisance, circuit-wise, but handy—the decimal system *is* familiar.

The ENIAC also has electronic circuits for multiplying, dividing, square-rooting and so forth. The multiplier uses a built-in electrical multiplication table to aid it in its

high-speed, ten digit operation. One very important unit in the ENIAC is the *master programmer,* which changes the machine from one computing sequence to another, as a complex computation progresses, in accordance with a pre-set plan. The master programmer even makes possible connections which enable the machine to choose the proper computing sequence when faced with the necessity for a choice. Thus it would almost seem that the machine *does* possess a kind of built-in judgment, and that there is some reason for the term "electrical brain."

It was mentioned that the fast memory of the ENIAC was limited. The slow memory, using punch cards, and IBM machines causes a great reduction in speed when it must be used. Also, although computation is all-electronic, data is fed in and results are taken out by electromechanical means—punch cards again. The limitations incurred may best be realized if we compare the time for a punch, about half a second, with the unit time of a flip-flop circuit, ten microseconds. The ratio is fifty thousand times.

Even more serious is the problem common to all digital machines, namely the difficulty of setting up a problem. These machines are not easy to use, and the sequence of operations for an easy problem may be very involved. If the problem is difficult, then, of course, the sequence gets more difficult, but the use of machine methods is mandatory. So, when faced with a real stinger of a problem, the scientist gets down to work, perhaps for months, just to figure out how to set up the machine. Considerable time is needed for the physical setting up of sequence connections too, but after that—brrrrrrrrrrrrp, and a solution which would take years by former methods begins to roll out in a matter of minutes.

Professor D. R. Hartree of England, who recently worked with the ENIAC, describes the solution of a problem in which this machine had to handle two hundred thousand digits. Now try writing digits as fast as possible. At a rate which will lead to errors and writer's cramp you may put down ten thousand digits in an hour. Even at this speed it will take twenty hours just to write down two hundred thousand digits—and no computation has been performed. The machine handled the numbers *and* performed the computation in this example in *four minutes flat.* It is not surprising that Professor Hartree is impressed by such speeds—he once spent fifteen years on the computation of the electron orbits of atoms. This is the kind of job that a machine calculator can be coerced into doing in a few hours, or days at most.

Their utility to science is obvious!

The ENIAC is only the first of its kind. The EDVAC—Electronic Discrete Variable Computer—is an improved machine, also built for Army Ordnance at the University of Pennsylvania. One of the chief

improvements is a larger capacity fast memory device, made possible by the use of acoustical delay lines for storage of numbers. Numbers are stored as trains of compression pulses bouncing back and forth in a two-inch column of mercury. Each delay line of this type does the work of five hundred fifty electronic tubes in the ENIAC, so that a substantial saving results.

The MANIAC—Mechanical and Numerical Integrator and Computer—is another Army Ordnance computer. It is being built at the Institute of Advanced Study at Princeton under the direction of Dr. J. von Neumann and Dr. H. H. Goldstine. This machine is to use a new type of fast memory tube which is being perfected by Dr. Jan Rajchman of RCA. This tube, called the Selectron, is a kind of cathode ray tube which is designed to store four thousand ninety-six off-on or binary signals—equivalent to about twelve hundred decimal digits. The binary digits are to be stored as charge on points on a cathode screen which are behind the interstices of two orthogonal sets of sixty-four wires each. An ingenious method of connecting certain of these wires together will enable electric signals to be fed in to pull the electron beam to any position for purposes of "reading" or "writing" with just thirty-two leads brought out. Even so a pre-production model of the tube looks a bit formidable, but it is phenomenally small for the memory it possesses.

Among some of the other schemes for digital memory being worked on are delay networks using loops of wire in wire recorders. This scheme may not be as fast as the acoustical delay line used in the EDVAC, but it has the advantage that the pulses do not have to be periodically removed for reshaping. One practical difficulty here is the necessity of waiting for the right point on the wire to come around before reading begins. Of course all memory of a number can easily be erased when need for it is finished, and the wire loop is ready to be re-used.

It seems that the Selectron is one of the best bets to speed up the operation of all-electronic computers. With its aid it should be possible to multiply two twelve-digit numbers in one hundred millionths of a second.

Such speeds may seem fantastic, but problems have been formulated and shelved because even the fastest present-day computing machines could not complete the solution in thousands of years.

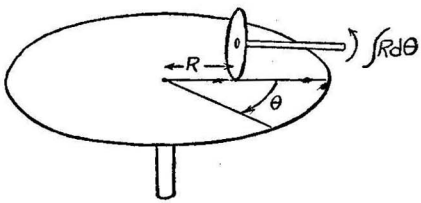
The Bureau of Standards, aided by Mauchly and Eckert of ENIAC fame and others, is now constructing some new machines of a general purpose type. This new digital computer is called the UNIVAC—Universal Automatic Computer—and is to be of a general purpose type suited for Bureau of Census work as well as Army and Navy ballistics and fire control research. The UNIVAC is to be very compact, using only about eight hundred

tubes, and occupying only about as much space as five file cabinets.

It is rather interesting that one of the limitations of this and other digital machines is the slow rate at which numbers are printed at the output. This limitation may be overcome in future machines by the use of a device called the "Numeroscope," recently announced by the Harvard Computation Lab. This device is nothing but a cathode-ray oscilloscope, which can trace the outline of any number, if the right signal is fed into its deflecting plates. This is no mean trick—it takes six vacuum tubes to make the numeral 2, for example, but it has been done, and numbers may now be flashed on the screen of a cathode-ray tube and photographed with exposures as short as one five-hundredth of a second.

The analogue computer, as we have stated works with analogous quantities rather than with whole numbers. Thus we may represent quantities by lengths, angles, voltages, velocities, forces and so on. Thus an electrical or an hydraulic circuit problem may be solved on a mechanical device, while an electrical problem may be solved on a mechanical device. One simple example of an analogue computer is the slide rule. Here quantities of any sort are converted into lengths, and since a logarithmic scale is used it is possible to multiply by adding lengths. If a linear scale is used we can add by adding lengths. Division and subtraction are possible by simply subtracting lengths in each case.

If we use angles, or angular displacements, to represent quantities successive displacements readily add to give a total. We can also use a differential like the one in the rear end of a car to add the angular displacements in two different shafts. The answer in this case, or a constant factor—gear ratio—times the answer appears on a third shaft. Direct voltages add conveniently, and alternating voltages add like vector or directed quantities, and so are convenient in the solution of problems involving directed lengths or forces.



Kelvin Wheel-and-Disk integrator. This device, which gives the integral of a radial distance with respect to an angle, is the most important unit in a differential analyzer of the electromechanical type.

Before going any further into discussion of the specific details of these devices it might be well to examine the relative advantages and disadvantages of the analogue type of computer. In the digital com-

puter the accuracy can usually be increased at the expense of speed, so that if we want to go from 10 digit to 20 digit accuracy we must suffer a decrease to half the original speed.

With the analogue type of computer it is only possible to increase accuracy if the lengths—or angles, or voltages, or whatnot—are measured with greater percentage accuracy. This may call for watchmaker techniques unless we can afford lengths or other analogous quantities. The difficulties encountered in any case are such that the accuracy is always much less than in any digital machine.

There are several advantages possessed by the analogue computer which tend to offset the decreased accuracy. One of these is its greater speed, which results partly from the fact that most problems are more easily set up for solution by analogue methods. Sometimes the analogue computer is used for a quick look at a problem, to narrow down the field which must be investigated with greater accuracy by the more involved digital computer. Another advantage possessed by the analogue computer is its ability—if the ability is built in—to perform certain mathematical operations in direct fashion. Thus, for example, a pivoted rod can be used to give the sine of an angle. This ability also accounts in part for the greater speed by the analogue method. Still another advantage is the ease with which empirical data in the form of curves may be fed into an analogue machine.

The first successful large-scale analogue computer was the Differential Analyzer designed by Dr. Vannevar Bush and others at M.I.T. The same type of machine has also been built by General Electric for its own use and for use in various Universities. The latest and most highly improved of these machines was recently installed at the new engineering school at U.C.L.A.

The differential analyzer is used chiefly for the solution of differential equations. In view of this fact it is rather strange that the machine cannot differentiate. However it can integrate, and since this is the inverse of differentiation its mastery over the calculus is quite complete. (The inverse of an arithmetical process is commonly used by clerks in stores who count back our change, and thus use addition in place of subtraction). The integrators in a differential analyzer are of the Kelvin wheel-and-disk type in which an integrator wheel rides on a rotating disk, and is turned when the disk turns. The amount of angular rotation of the integrator wheel depends on its distance, R, from the center of the disk, and the angle the disk turns through, θ. This, by definition, is the integral of R with respect to θ.

The integrator is the most important device in the differential analyzer, and as such has received a great deal of attention. In 1944 G.E. engineers came up with a de-

vice in which troubles caused by slipping of the integrator wheel on the disk were virtually eliminated. This device was essentially a servo follow-up system in which light beams were passed through a polaroid disk attached to a very light integrator wheel. These light beams then went through other polaroid disks, then to phototubes, to an amplifier and a motor. The motor then caused the second and third polaroid disks to follow the disk on the integrator wheel with the customary boost in power level, or torque level.

Among other important components in the differential analyzer are the input tables. At these tables, in the older machines, operators followed plotted curves of functions which were to be fed into the machine with pointers, and thus converted distances on the curve sheets to angular rotations. In the newer machines light beam photocell servomechanisms accomplish the same thing without the aid of skilled operators. Known functions, of course, are generated by other and simpler means.

Because the differential analyzer handles quantities in the form of angular displacements the process of adding is accomplished by the use of differential gearing. To solve a differential equation the machine must first be set up so that the right shafts are connected together by the right gear ratios. When all is ready the data in the form of curves is fed into the machine at the input tables, the known functions are fed in from function generators, and the output pens are moved from left to right, all in synchronism. Adding wheels, integrators, input table lead-screws and so forth all begin to move and perform the operations required by the equation being solved. The totals of the quantities on each side of the equation are held equal by a servomechanism and the shaft which will give the function which is the desired answer moves the output pen up and down as it is pulled across a sheet of graph paper. Thus the answer appears as a curve, or a set of curves.

The accuracy of these results depends not only upon the accuracy with which these final curves can be read, but also upon the accuracy of the original data, and the accuracy of the various servos involved in the solution. Typically, about one-tenth of one percent, or three digit accuracy can be expected. If some of the components have been forced to accelerate too rapidly because of a poor choice of gear ratio, or if a lead screw has been forced to the end of its travel, the solution may be completely wrong—the analyst still has his headaches. These troubles are ordinarily avoided by making preliminary runs to determine the proper ranges of operation of all components.

Among the other types of analogue computers commonly used in engineering work are the various

kinds of network analyzers. A large electrical power network may be exceedingly complex, due to the more or less random geographical distribution of loads and generating plants. The effect of short circuits, arc-overs due to lightning, and load distribution must be studied with the aid of models, so that the design of circuit breakers, lightning arresters and so forth can proceed intelligently. Tests cannot be made on the actual power network, as they can on communication networks, because of the possibility that damage to large and expensive equipment might result.

The earliest type of power network model was the D-C Network Analyzer. The representation of three-phase alternating current systems by direct-current models of this kind has definite limitations, and the next step was the development of A-C Network Analyzers. These models, although they represent a three-phase system by a single system are much more versatile than the D-C Analyzers.

We may ask if such models should really be classed as computers. Fundamentally, these analyzers are merely models of systems which are too complicated for direct analysis, and too large for direct measurement of variables under all possible conditions. Much the same kind of model-making is carried on in the study of aircraft antennas using model planes and microwaves in place of short waves. However, if we examine some of the uses to which Network Analyzers have been put, it seems safe to class them as computers. Because of the use of electrical quantities in these devices and because of the flexibility of interconnections possible, they have been used for the solution of such problems as the flow of microwave energy in wave-guides, the flow of compressible fluids in pipes, and even the solution of Schrodinger's Wave Equation.

Another type of network analyzer is the Transient Network Analyzer, which can show more clearly what happens in a power network when short circuits and overloads occur. This device may also be used to study analogous problems such as the amplitude of transient vibrations in mechanical systems when sudden shocks or overloads occur. The inverse of this kind of thing is the mechanical model used to study what goes on in a vacuum tube. In these models stretched sheets of dental rubber are used to represent electrostatic fields, and ball bearings serve as electrons.

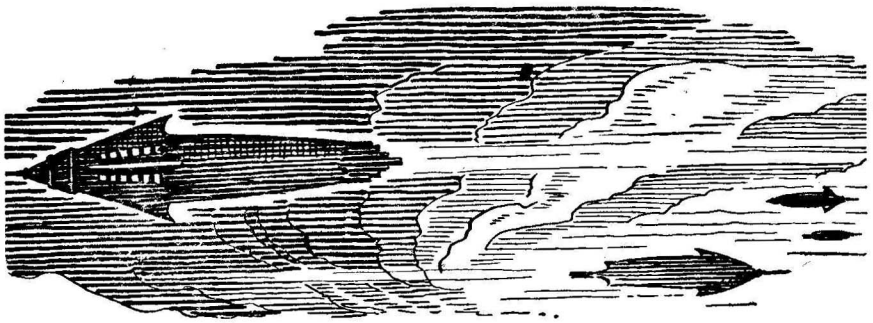
The differential analyzer is more versatile than the network analyzer discussed above because it can integrate, differentiate—in effect—and multiply, and thus solve rather complicated differential equations. These functions are performed by mechanical or electro-mechanical devices in the differential analyzer. If these things could be accomplished by purely electrical means, we would expect a great increase in

speed, and some decrease in size and weight. Such machines have been built by Westinghouse and Caltech, and seem to promise a fair increase in speed over the old differential analyzer. It seems inevitable that the use of many vacuum tubes will lead to somewhat lower accuracy and less dependability. Another difficulty with present types of electronic differential analyzers is that integration can only be performed with respect to time as the independent variable, so that the solution of certain problems is not easily possible.

Many other kinds of analogue computers have been perfected in the last few years—the field is definitely "hot." Completed designs include such gadgets as the Bell Telephone M-4 Director, which used radar signals to figure out in a twinkling where an antiaircraft gun should be aimed so that the shell and a plane might meet. Undoubtedly work is in progress on computers which will make possible of solution the "problem of delivery" of the modern atomic warhead. These latter-day buzz-bombs will be sufficiently lethal to warrant their carrying along their own computers.

Many scientists are disconcerted by the fact that by far the greater part of the computer research being carried on today is under the auspices of the Armed Forces. To be sure, we in the United States seem to be far ahead of anyone else in the world in computers. This may augur well for National Security if some desperate bludgeoning struggle is soon to occur. From the longer range point of view it seems that it is particularly desirable that the scientist whose pure research may lead him to yet undiscovered fundamental truths be also equipped with this new and powerful tool.

THE END



LOST ULYSSES

BY WILLIAM L. BADE

***A strange** Odyssey indeed, with no possible hope of return to a million-year-gone Earth! And even the re-created Earth was dangerous to its gods!*

Illustrated by Brush

To wander everywhere and find no home; to outlive generations and belong to a generation centuries dead; to achieve greatly and never to possess that achievement—this is the fate of that lost Ulysses, the Starman.

For Clay, the first approach of consciousness was marked not by light but by pain. Everything hurt. His arches and calf-muscles, his thighs, his abdomen and chest and back, his arms—everything ached as though he had been beaten with clubs. A stabbing, throbbing agony lay in his brain.

Finally he thought: *I'm not dead—*

For a while he was glad to be alive and afraid he might yet die. Then, as the pain became terrible, he was afraid he was *not* going to die.

Once he heard a voice, but forgot it immediately in the fullness of the pain.

Finally he forced himself to open his eyes. Then there were vague masses of light and darkness which refused to come into focus. Gradually details appeared. There was the floor, very close to him—he was lying on it—and over there was the drive control, and there the instrument bank.

He was in the navigation room on board the *Gibbs*.

With a rush, his memory came back—takeoff morning—Kerrigan standing in the sunlight with his hands in his pockets, coolly nodding farewell—the march to the ship—coming into navigation section—Sonnemann with a gun in his hand—

Sonnemann had shot him with a stun-gun. No wonder he felt so miserable!

Clay turned his eyes and found the chief navigator sitting in one of the observation seats, peering intently into a scope and operating its controls. He was muttering to himself. Clay finally caught a couple of words. ". . . beautiful, *beautiful—*"

Clay lay there and ached all over and watched.

Abruptly, Sonnemann leaped to his feet and faced the door with his weapon in his hand. Clay turned his head and saw the door rising—beyond it three crewmen, guards, with guns in their hands. Ship guards have reflexes about people who point guns at them. The three must have fired almost simultaneously.

There was a loud thud as Sonnemann's body struck the deck.

Clay forced himself to his feet and stood swaying as the guards came into the room, followed by Captain Lasher. The captain knelt and examined Sonnemann, then rose.

"Dead," he remarked.

Clay stumbled over to the instrument bank and dropped into a seat. "He pulled a stun-gun on me," he choked. "Shot me as I came in."

"Carry Sonnemann to his room," Lasher ordered the guards. "Make sure nobody finds out about this yet. And one of you stay outside here and see that no one bothers us." When the guardsmen had left, taking the body with them, he turned to Clay.

"Lieutenant, I think you should investigate the matter of our position. After the jump there were no stars visible in my instruments."

Clay stared at him, then turned and peered into the scope in front of him. There was nothing but blackness in the field. He ran the light gain way up, but there was nothing to see. The power was on; the instrument should be functioning.

He twisted the gain control clear over to the stop. Ghostly patterns of light appeared, grew brighter and sharper.

Spiral nebulae.

It was like a nightmare, seeing those galaxies there. They were too many, too close. They clustered in groups of a half dozen; they had every random orientation to the ship. They lay in every direction. There must have been hundreds of them.

Clay stared wide-eyed at the impossible sight at least a minute before Lasher pulled him away from the scope and asked:

"What is it?"

Clay told him shakily. Lasher stood musing for a moment, then said: "Let's check the directrix card."

They removed the thin metallic card from its temperature-controlled nitch in the drive control and clamped it on the micrometer plate. Even at first glance, the thing was obviously handmade, Sonnemann's work.

Clay forced himself to make haste slowly, for the result of his

calculations would be of vital importance. Each of the hand-punched rectangular holes piercing the card had determined the operation of some function of the ship's drive in the interstellar jump made during his unconsciousness.

They had to know where they were.

The card was a fantastic thing. The radius vector holes were way over to the right. Clay's hands shook a little as he adjusted the micrometer.

The job took a quarter of an hour. In the end, the computer clucked a couple of dozen times and ejected a card stating their position in stan-

dard astronomical co-ordinates. Clay took the thing and looked at it. His eyes skipped over the right ascension and declination to the radius vector—and froze there.

14, 617, 000 PARSECS.

The number lay there, ink marks on a piece of cardboard. He refocused his eyes and stared at it, mentally translating it into light-years and years of tau-lag.

"Well?" Lasher asked.

Clay handed him the card and waited. Abruptly, by necessity, he dropped into a chair. Lasher did not appear disconcerted. "If this is correct," he said finally, "we will have to consider carefully what action we ought to take. But I want you to recheck this result first, Lieutenant Clay."

There is a law of nature which sets a limit to the speed of propagation of physical effects. Two points in the continuum are separated by an interval of space-time, and there is no way in the universe of passing from one to the other without transversing all the components of that interval.

Markhoff, a crazy combination of engineer and cosmologist, delved deep into the nature of the continuum and found a way out of the dilemma for star-hungry mankind. His mathematics described a fantastic rotation of the imaginary time-axis around one of the space-axes—and, fantastically, he himself found corresponding physical effects in his laboratory.

The Markhoff drive carried men to the stars. By ship-time any journey, however long, required but a fraction of a second. By world-time, it took somewhat longer than light would need to cover the same distance. The world-time lost to the men of the ship in an interstellar jump was call tau-lag, and over a course of nearly fifty million light-years—

All of a sudden, Clay remembered the icy clear air of a winter night in his home town, and the crystal blue of a summer sky, and the green color of grass. He thought of Kerrigan standing on the concrete in front of the barracks building at the Holland Valley base, hands in his pockets, nodding an aloof farewell.

Fifty million years. The bleak thought sank into him of the time and the decay, of human civilization that must have withered and disappeared aeons ago, and of a thousand human beings flung far out on the black horizon of the universe.

Gradually the room came back into focus. Captain Lasher was staring at him. "Lieutenant Clay," he repeated.

Clay nodded and forced himself to take the measurements over and remake the calculations.

14, 618, 000 PARSECS.

A creeping agony of exhaustion lay upon his limbs. He sank into the chair behind his own desk and slumped forward. He'd have to sleep off this stun-gun hangover.

"Now," said Lasher, "we have to decide what to do. First, let's review the situation. The announced destination for this trip was the Beta Hydri colony, but I had special secret orders to search space within seventy light-years of the sun, find a suitable planet, and establish a new colony there. Sonnemann said he'd try Mu Herculis first, and that was supposedly the terminus for the first jump. But Sonnemann must have gone crazy. That's the only explanation. He changed our destination from Mu Herculis to Wolf's Nebelnest, which is a little less than fifty million light-years from the sun. The tau-lag amounts to over fifty million years. If we were to return to the home galaxy, it would be more than a hundred million years. Therefore there is no point in going back—"

Clay broke in. "We *can't* go home, sir. We've lost our line of orientation. We couldn't aim the ship for the jump. Even if we could find the galaxy, it wouldn't do us any good. In a hundred million years of tau-lag the sun would have gone four-tenths of the way around the galactic nucleus."

He smiled, and his eyes were bright with a strange excitement. "We could never find it," he said. "Not if we hunted all our lives. I wish we could, because I'd like to see what's happened there—but we can't. We're absolutely on our own."

"All right," Lasher said. "What do *you* think we should do?"

"The obvious thing," said Clay, "is to enter one of the galaxies nearby, find a planet, and settle. We're all set up. We were supposed to found a colony. We have everything it will take."

The captain nodded. "That was the idea I had," he stated. "There's another thing—I think it would be best to keep the actual situation a secret until the colony is well established. Knowledge of it might have a demoralizing effect on the colonists—even perhaps on the crew."

"Yes," Clay agreed, "we'd better do that. It wouldn't bother the crew, but the colonists . . . hm-m-m . . . suppose we told them just about half the truth—"

It took only a few minutes to plan that mass deception. When they were done, Lasher sighed and said: "I'll hate to give up star-hopping, but I guess there's nothing else to do."

Fifty million years. The situation fired Clay's blood. Here they were, absolutely on their own, at the terminus of the longest voyage ever made by men—with no possibility of return. He felt sorry for Sonnemann. His chief in the navigation section had never been a happy man. Felix Thom had once described him as a non-sensual materialist. He had been too absorbed in astrophysics and the Big View of Things to get much fun out of life—a pitiful example of the human animal trying to exist as pure intellect.

He had gone crazy, according to

Lasher. Well, you could call it that. He had taken a last, desperate means of tearing himself away from the earthliness he despised and feared. The poor guy—

Clay was now faced with an interesting technical problem. The *Gibbs* was far out in an uncharted region of space. Before he could set up the drive control for an interstellar jump, he had to know the distance of the destination.

He considered the method of moving the ship and observing parallaxes, but rejected it as too slow. Another swifter if somewhat trickier technique recommended itself. He observed the apparent magnitudes of the brightest stars in the galaxy of his choice, computed their absolute magnitudes from the characteristics of their spectra by means of astrophysical formulas, and so arrived at their average distance.

A one hundred and ten thousand light-year jump landed the ship in the midst of the galaxy's star clouds. Then Clay started star-hopping. The fifth system he tried had a planet which appeared suitable for human colonization. It was ten thousand miles in diameter and evidently, from the broad seas which covered much of its surface, had plenty of oxygen. After consulting with Lasher, Clay set the ship down in a broad river valley about thirty degrees from the equator.

On Clay's advice, the captain confided the secret of the ship's location in Felix Thom. Felix was a mass of paradoxes incarnate in the flesh. He was a huge man, red of face and hands from years of exposure to the elements. He had worked as a farmhand, a lumberjack, a bricklayer. Adept at handling people, he was ship liaison officer between crew and colonists. He had written and sold a book of poems called "Stars and Starmen" about men in the deep heavens, and was currently engaged in gathering material for a book to be called "A Starman's Journal." It was too bad, Clay reflected, that the thing would never be published now.

Clay attended the meeting in which Felix broke the news to the colonists. About a tenth of their total number was present in the *Gibbs'* assembly chamber; the rest were listening over the loudspeaker system. Up front, on the stage, Felix was smiling and nodding greetings to men he knew. When the hall was finally filled to capacity, he began speaking:

"Hello, everybody . . . I've got some news for you. We've landed."

There were cheers and applause.

"But I've got a surprise for you, too. Before I tell you what it is, I'd better explain the situation. The Interstellar Board of the World Directorate is made up of five men, chosen for their training and interest in the public welfare. They form the policies of the Interstellar Service and issue orders to the officers of particular ships."

Sensing that the "surprise" was not to be entirely of a pleasant nature, the colonists became apprehen-

sively silent. Now Felix had to exert all the force of his powerful personality to convince them that they didn't really mind being double-crossed.

"During the last few decades the Board has found that people don't want to start new colonies any more. As a result, its long-standing plan of expansion in the extrasolar colonies has been crippled. In the interest of public welfare, the Board decided that it would have to resort to deception, much as its members hated to do so. It would have to send colonists expecting to go to old colonies to planets where no colonies as yet existed."

So far, he was telling the straight truth, in a sugar-coated form. The people in the assembly hall looked shocked and dissatisfied as they perceived the direction his speech was taking. They had expected relative security at a long-established colony. Instead they were to face hardship and unknown danger in the founding of a new outpost.

"The preflight announcements said that this trip was to the Beta Hydri colony. This was not actually the case. Special orders were issued to Captain Lasher by the Interstellar Board directing him to search space within seventy light-years of the sun for a suitable planet and to establish there a new extrasolar colony.

"The ship has landed on the fourth planet of the star Mu Herculis. This star is only twenty-eight light-years from the sun. The planet is well suited to human habitation. Captain Lasher has ordered that debarkation begin at once. At this moment supplies are being unloaded."

Some of the colonists had started talking to one another. Some were shouting objections at Thom. Now was the moment when he had to gain control over their emotions. He held up a hand. "Please," he said, "just a moment."

When quiet had settled, he went on: "You haven't got anything to worry about. You'll have to work hard in the beginning, but you'll have the advantage of the best modern equipment and weapons. And once you have the colony established, it'll be all yours. You've got a virgin planet to work on. Your children will take it from you, and their children will get it after them —and some day Mu Herculis Four may be great and famous in human interstellar civilization. Remember"—he raised a big red hand at them—"this is a time in history when the human race has to expand beyond its home world. You're going to have a part in that expansion. You're going to take this planet, build your own towns, clear your own farmland, raise your own children on it.

"I almost envy you," he concluded abruptly.

It must have been quite a letdown to leave that meeting, still feeling optimistic and mildly heroic, and march out of the ship into the midst of the jungle. The crew had already

cleared a space around the *Gibbs* so that they could begin unloading crates of equipment. All around was a tumbled, smoking mass of felled vegetation and a wall of foliage so high that there was no visible horizon.

The work started at once. Crew members armed with Hemmingsens cut swathes through the growth, their guns filling the air for several minutes with bellowing sound and acrid ozone. Tractors shoved the stuff into piles and skimmers mounting gravity engines carried it away. Gangs of colonists equipped with atomic shears and gouges followed, clearing away the undergrowth and the tree trunks, leaving the ground almost bare.

Several times during the day, large animals blundered into the guard lines and were killed by Hemmingsen blasts. The insects, too small and too swift to be destroyed by such heavy weapons, were worse. They hummed and sang through the air along looped and twisted paths which were most unnerving to watch. Some of them stung or bit. A steady stream of resulting casualties flowed into the ship dispensary until Lasher ordered all the workers to wear heavier protective clothing.

By sunset, a half-mile circle had been cleared of vegetation. The colonists who had been out on work-gangs streamed back into the ship, tired and full of stories about the day's incidents. On the whole, they seemed confident and satisfied.

It was not a bad start.

Clay was out watching the work. He had been on the expedition which colonized Beta Hydri Three, and the contrast in situations and methods was interesting. The earlier settlement had been on a grassland plateau fifteen hundred feet above sea level. There had been no jungle to fight. The ultimate problem had been water, and it had been solved by drilling a number of deep wells.

In this flat river-bottom country, the difficulty would be to keep unwanted life-forms out. Once the jungle had been driven back, the land would be fantastically productive.

After supper Felix and Harry Osgood turned up in Clay's room. Harry was a wizened little ex-professor of history. Knowing mankind's past, he had remained unsatisfied; there were millennia of high history yet to come. He had left the quietude of a university for the lustier life of the Interstellar Service, from which he could survey the events of the passing centuries and so test his theories of historical development.

He sat down on the bunk and filled his pipe, grinning at Clay, eyes bright with excitement. "Felix told me," he said. "I can't help being intrigued by the situation. Fifty million light-years! Good heavens!"

"It was interesting," Clay said after he had turned his chair around to face the other two. "I've been trying to figure the angles. Sonnemann batted us clear off to hell-and-gone—" He cracked a smile.

"That's what I named this place when I got a look at it this afternoon: Hell-and-Gone. Anyway, this planet—this sun—they haven't got any real names. No one was ever here before. This galaxy is in the Nebelnest along with several hundred others—and the whole world is near fifteen million parsecs from Sol. We're planting a colony. In a few thousand years it ought to grow into an island of human civilization out here."

"While back home there may not be any humans or any civilization," Harry interpolated.

"That's right—"

Felix sat with his elbows on his knees, massive head thrust forward. "I've been thinking about it from another angle," he said. "You two see the thing in general terms. I see it in terms of its details. Has either of you wondered what we're going to do here after the colony has been established?"

"I wondered," Clay said, "but—"

"Lasher has the idea that we'll settle, along with the colonists. I know people better than he does. I don't think we can do it. The crew and the colonists will be at each other's throats despite everything I can do."

"I never thought of that," Clay said. "But there's another thing—the crew itself. We're a peculiar bunch. We were all misfits back home; that was why we joined the Service. After running up a century of tau-lag, a man gets so he doesn't feel at home anywhere. He can't settle down. I know I couldn't feel any enthusiasm about becoming a pioneer and finishing my days as a tiller of the soil."

"Still, it might be a good thing for us," Harry objected.

Clay shook his head. "Don't delude yourself. We've all been lonely, I know. I remember when I got back from my first trip. My old friends were all gone. Everything had changed. There were new styles, and a new generation was running things. I could scarcely find anything to do except take in shows and sit around in the music room at the base. But I got used to it. And later I got to feel that there wasn't a finer way of life. With three months inter-trip vacation and a thousand credits pay to spend—"

"Dan dropped out of it, though."

"Daniel Kerrigan was all goofed up. You knew him—bitter. He needed a chance to stop running and think for a while. And I'll bet he joined the Service again. It just wasn't in him to squander his life in a few decades when he could spread it over millennia."

"Tom is right," Felix stated. "There are exceptions, but most starmen have a built-in abhorrence of being tied down to one place—or one period. As soon as the colony's finished, the crew will be wanting to lift; if not for Earth, then for somewhere else—or for nowhere, if necessary."

"Oh, yes," Clay said. "That reminds me." He opened a drawer of his desk and took out a thin, an-

cient volume. "I found this in a bookshop in New Orleans when we were on Earth." Faded gilt letters on the worn binding read "The Intellectual Hobo in the Modern World" by Wendell Olson.

"This was published way back around the middle of the twentieth century," Clay told them. "The interesting thing about it is that a lot of what it says applies rather closely to us. Quite amazing, altogether. You can read it later, but just now I'd like you to listen to this one passage. It seemed to me when I read it that it fitted us to a gnat's eyeball." He opened the book to a marker, cleared his throat, and began:

"Individual development, in an undetermined way; and survival—these are the only things that would have the semblance of importance in our age. Neither eternal varieties nor shining societies of tomorrow can seduce by their glamour. Neither material nor psychological security can operate as a reason for living. A wild jaunt into the unknown, a soaring into the mystery and chaos of existence—this is the privilege, duty, and fate of the in-

tellectual hobo, the bearer of the torch who did not strike the match and who will not see the bonfire, but is engaged in a perpetual marathon between the past and the future."

"Rather extreme to be applied to us," Felix commented. "But I see your point—endless star-hopping, life spent in the deep heavens—'Wild jaunt into the unknown'—a neat, if accidental, description of this particular trip."

"Not only that," Clay said, "the whole attitude implied is akin to our own. This Olson lived back in one of the terrible periods of history. The old tradition was breaking up, and life was a rather desperate affair for those with eyes to see. But we represent the same type of man he discussed as developed under conditions of peace and ease." He shook his head. "I don't know what we'll do. But I'll bet my uniform we don't stay here."

The business of establishing the colony proceeded. More of the valley jungle was cleared. Technicians from the ship laid the foundation of the town in huge flat blocks of artificial stone shaped in an atomic former. No alien foliage would grow through that harder-than-concrete stuff, with its synthetic-sealed junctures.

As land was cleared, plows went over it, terrestrial microorganisms were seeded in, and hardy fast-growing grains were planted. The main wall, a barrier of man-made stone ten feet thick and fifty feet high encompassing the entire settlement, was begun.

The labor of conquering and transforming the wilderness stimulated the colonists. But there were other factors which tended to damage their morals. Prepared biological defenses broke down before microbes and viruses native to the planet and men were hospitalized or buried. The alien insects continued to take a toll, despite precautions. Driven by Lasher's inexhaustible energy, by a craving for security, and by the simple challenge of the situation, the colonists sweated ahead with the work and made rapid progress.

The crew worked with them, its trained technicians handling the big machines and installing equipment in the town. For nearly thirty days after landing, there was a sense of solidarity uniting the two groups which were laboring on the same task. Then friction began to develop.

That transformation of feeling was a gradual, yet a rapid thing. The starmen were used to the easy-going morals of the cities, while most of the colonists came from the rural areas. Interstellar Service men could see nothing wrong in a little love affair with an unattached colonist woman and many a country lad envied and hated the green uniform and suave ways that drew his girl away from him.

There were fist fights in the streets of the partly built town that

produced bruised faces and acid hatreds. Felix was near his wit's end, trying to find a way of stopping the conflict without simultaneously ruining morale all way around. He ordered longer hours of work, so as to leave the men less leisure time. He sent squads of guards into the town, armed with stun-guns and the authority to arrest anyone found fighting. He stopped the crew's liquor ration and ordered the starmen to quit meddling with the colonists.

On the twenty-sixth day after landing, the first cases of the blue sickness turned up in the dispensary. Medical technicians verified that it was not a terrestrial disease and started a frantic day-and-night effort to isolate its cause and find a cure.

On the twenty-seventh, the rains started. Water sluiced out of the sky in quantities that changed the region to a sea of mud. On the twenty-eighth, working conditions outside of town were indescribably miserable. By the thirtieth, they were altogether impossible.

So a thousand colonists and more than a hundred crewmen stood idle. Cases of the blue sickness increased.

On the thirty-first, the situation exploded.

Trouble was bound to come that day. It could just as well have been a simple, disorganized riot—dangerous enough, but not quite deadly.

But between the loss of momentum caused by the rains and the half-panic evoked by the epidemic of blue sickness, the colonists had one common idea—to get off this alien planet. Somewhere early in the day's confusion, a single man assumed leadership and directed the fury of the mob to the one end its members agreed on.

Clay was in Thom's office when first news of the trouble arrived. The intercom unit peeped. "This is Nichols," it said. "A riot has started in the town. It looks like a bad one."

"Equip all your men with stun-guns and gas bombs," Felix ordered. "Get the longboats ready to launch. I'll be right up."

Clay trotted behind him as he hurried down the corridor and rode the elevator up to the launching stage. Guards, wearing their S.P. armbands and clipping stun-gun holsters to their belts, were running toward the locks of the two space-boats. Others were carrying racks of mist bombs. Within a minute, the launching gates had slid down and the two boats were slipping out into the air five hundred feet above ground.

The boats coasted down over mud fields and across the curved white edge of the stone platform that was the town's foundation, approaching the section where residential blocks were partly built. Looking down, Clay saw a seething mass of struggling colonists and crewmen. The latter were outnumbered, but had concentrated their force and were

fighting with their backs to the wall of a building.

The ship guards, under Thom's direction, wasted no time. A rack of gas bombs dropped from the lead boat and exploded into mushrooms of irritating gray mist on the pavement below. The mob scattered in every direction. After a moment's hesitation, the embattled group of starmen plunged at a dead run down the street toward the ship.

Suddenly there were shots. Three green-uniformed figures fell in mid-run and rolled on the pavement. The rest stopped, shouted their fury. Guns appeared. Shots sounded and colonists dropped.

One of the fight-crazed starmen had a Hemmingsen rifle. He fired from the hip and thunder crashed and rolled through the town. The bolt from the weapon blasted through a group of colonists a hundred feet away. Clothing and flesh flared white for a moment; the Hemmingsen beam struck a wall fifty yards farther on and gouged a white-hot furrow in the smooth stone. Then there were five smoldering clods of dead flesh that had been human beings lying on the street.

At that instant the two boats dropped and grounded. Ship guards poured out, stun-guns in their hands. The loudspeakers roared: "Stop this fighting! Throw down your weapons. This is a direct order. Drop your guns!"

The guards spread, one group toward the starmen down the street, the rest in a line that swept the colonists back. They stun-gunned anyone who resisted, including a number of crewmen.

For the moment, the riot died.

Back in the ship, Lasher called Clay and Thom into the control room. As soon as the three of them were alone, he said: "Felix—I want your advice. You agree with me that this situation menaces our entire plan here?"

Thom nodded.

"All right, then. We will have to make a new set of plans. The first and most vital point is that of colonist-crew relations. We have to get those under control immediately. Do you have any ideas?"

"The colonists will settle down once they can get back to work. But as long as this rainy season lasts, we're going to have trouble. The best thing that could possibly happen would be for the medical section to crack this problem of the blue sickness. If we could stop cases of that, and get the colonists back to work, things would settle down."

Lasher nodded. "But we have to do something right away," he said. "And down in the dispensary they say they can't do anything yet. It may be another week. And these rains—" He shrugged. "Couldn't you talk to them, or something?"

"I could try—"

The intercom peeped and Lasher flipped a switch. "One of the guards has come in from town," a

voice reported. "He says the colonists have mutinied and captured the rest of the guards as hostages."

"Send him in!" Lasher snapped.

The guard that came in was a poor-looking specimen. His gun was gone. His uniform was smeared and spattered with mud. Blood from a cut over his cheekbone had dribbled down across his face and onto his collar.

He saluted Lasher: "Guardsman Fonder reporting, sir."

Lasher returned the salute. "Report!"

"We had divided into small groups to cover the entire town. My group was surrounded by colonists with guns. They threatened to kill us if we tried to use our stun-guns. We surrendered. They took our guns and stun-gun shields. Then they took us to a building on the north side of town. Some of the other guards were already there. Within half an hour, they were all there—tied up. The colonists were mad. One of them beat me up while I was tied."

"How many colonists were there? Lasher asked.

"About fifty that I saw, sir. They finally untied me and told me to come here and give you an ultimatum."

"What was the ultimatum?"

"They want you to evacuate the ship, leaving all weapons and equipment behind. Unless you do this, they'll kill the guards they have as hostages."

"I see," said Lasher. "And what do they want the ship for? Did they say?"

"Yes, sir. They said that this planet is just plain hell, what with the jungle and insects and rain and disease and all, and they want to go to Beta Hydri, where they signed on to go. They're pretty sure you won't take them if you can help it. So they're trying to force you. They promise not to hurt anybody unless you try something funny."

"I see," Lasher said. He glanced at Felix and Clay. "Very well, guardsman. Go to the dispensary and have that cut on your face treated." The crewman saluted and left.

Half an hour later, Lasher launched his counterattack. The two ships' boats dived out of their gates and down toward the town, heavy mounted wide-dispersion stun-charge projectors firing at full load. They passed over the settlement once, made a five-mile turn, came back over, dropped, and grounded. Guardsmen and crew members armed with automatic pistols and Hemmingsens poured out and began searching the buildings.

Suddenly a Hemmingsen beam flashed and roared out of a doorway down the street and tore through one of the searching parties, killing a dozen men. Somebody shot back and wrecked the doorway, but the sniper was already gone.

A machine gun blasted from somewhere, and for a moment the street was filled with echoes and

ricocheting bullets. Another couple of crewmen went down.

There was a shout from inside one of the buildings and a number of the searchers ran into it. Clay, inside one of the boats, thought: *They've found them.*

Presently the crewmen came out again. They were carrying one—two—three guardsmen. Three. That was all.

The town looked like a village of the dead. The streets were empty except for the blasted corpses and the party of searchers hastily returning to the spacecraft. Walls were scored with bullet marks and Hemmingsen beam pits. The starmen hurried into the boats and Lasher gave the order to lift.

The longboats rose, starting a skyward dive that would carry them a thousand feet up and then back to the ship. When they were about a hundred feet above the pavement, several Hemmingsen beams reached up from doorways and windows below. Clay saw the other boat pierced by at least two beams. White light flared from within it; it staggered and dropped to the stone below. Striking, it burst open and started to burn. The magnesium alloy of its hull flared blindingly and clouds of white smoke rose.

In a moment, there was nothing but a heap of incandescent slag lying there on the pavement.

Clay's boat rose high into the blue and dived for the launching gate on the ship's upper surface. The gate closed.

They piled out of the boat. Lasher rushed over to the intercom, flipped the general hookup switch. "All officers and crew members, attention! Stand by for immediate takeoff. Engine room, give me standby power. Control room—be ready for lift!"

Seconds later: "Engine room reporting—standby power ready."

"Control room reporting—ready to lift."

Lasher took a deep breath.

"Take her up!"

The *Gibbs* sat in an orbit ten thousand miles above planet surface. In the assembly hall, Lasher was speaking to his crew, telling them the situation and explaining its origin.

For a man who had just suffered a signal defeat he looked cheerful enough.

Clay, sitting beside him at the table on the stage, knew why. Only an hour before, consulting together, the two of them had conceived a plan that offered almost breathtaking opportunities.

The crewmen seemed to be taking it pretty well. As Lasher described their location, a few jaws went slack, a few faces became a shade whiter, a few startled comments burst forth. But no one appeared dismayed. Now the starmen were listening and watching with intelligent attention.

". . . we could not give in to the

colonists," Lasher said. "Hoping to save the captured guardsmen and maintain our hold on the planet, I ordered a counterattack. We strafed the town with heavy stun-gun fire, but a number of the colonists were wearing stun-gun shields taken from captured guards. They murdered all but three of the hostages before we arrived. We lost thirty-five men in the engagement and were forced to leave the planet, so that the counterattack was a complete failure.

"In fact, the entire project has fallen short of success. The colony is not yet completely established, and we have lost control of it. The question now arises, what are we to do? Lieutenant Clay has invented an admirable plan, but before he tells you what it is I want you to speak out with any ideas you yourselves have. For example, can anyone think of a plan for re-establishing peaceful relations with the colonists?"

Nichols, Crew Commander, stood up. His face was flushed. "Peaceful relation!" he spat out. "We should go back down there and give 'em a taste of our Hemmingsen heavies. Let 'em pick between surrendering and dying. They'll give in soon enough, once they've seen a hundred megawatt beam go plowing past the front door."

"Our mission is to insure the survival, not the extinction of the colony," Lasher reproved.

"They murdered twenty-nine of my boys," Nichols said. "I'm for givin' 'em back a taste of their own medicine."

Lasher shook his head. "I could never allow such action."

Felix Thom took the floor. "As liaison officer," he said, "I have been in closer contact than the rest of you with the colonists. In my opinion, the colonists will not accept us peacefully unless we agree to take them to Beta Hydri—and that's impossible. The violence which Nichols suggests would be worse than useless. It would not even gain us secure possession of the town, since snipers with Hemmingsens could escape our attack and survive in the jungle of the hills beyond the valley. As members of the Interstellar Service we must not allow ourselves to be motivated by such emotions as revenge.

"Besides, the whole idea of attack is wrong. When men try to destroy each other, they only too often succeed."

He paused, surveying their faces with his shrewd little eyes. Then—

"I'm convinced that this planet is lost to us. I think that we should return to the home galaxy."

There was a stir of surprise. Lasher said: "That's impossible. Ask Lieutenant Clay."

Felix turned to Clay. "Tom—wouldn't it be possible to derive a line of orientation from a study of galaxy groupings at distances of several million parsecs? Don't you think you could recognize the Quintet in Pegasus and other such for-

mations from here, and figure the direction back home?"

Clay sat thinking for a moment. "It's possible," he said. "Uncertain and risky, but possible."

"It's no use going back to the home galaxy," Lasher said. "The tau-lag would be a hundred million years, even if we could find it."

"So—on a hundred million planets that were probably colonized, *all* the human race would have died out?"

Lasher looked baffled. "Your plan is not logical," he said finally. "I can't see it. Anyway, Lieutenant Clay—"

"We can go back and see," Felix said. "If we don't find human beings, that needn't bother us. There are more than eighty colonists in the dispensary with nothing more wrong with them than a few insect bites and touches of the blue sickness—which can be cured. Twenty-six women, forty-two men, and fourteen children. We can start another colony if we have to."

Captain Lasher tapped Clay's arm to attract his attention and nodded a go-ahead to him. Clay rose and looked Felix in the face.

"Your plan would be all right," he said, "if we didn't have any place to go. But we do, as I'll show you. First, let's analyze the situation logically."

The assembly hall was suddenly very quiet.

"We can't stay at this colony," Clay asserted. "You said that yourself, Felix. Those mutineers down there are boiling mad, and they won't let us return peacefully unless we promise to take them where they want to go. And we can't do that. There would be only one result if we went back down, and that would be more useless bloodshed. It's our duty to insure the survival of the colony, and paradoxically enough we can do that best by deserting it."

Bafflement showed on the faces of the crew members in the hall. Felix made an impatient gesture.

"So we will leave," Clay said. "The question now is, where will we go? Ideally, some place where there is a human culture, preferably an advanced technological civilization. Well, there isn't anything like that around here right now—but unless the colony down there gets wiped out, there will be a civilization on this planet sometime in the future."

Understanding came to Felix's face like the burst of a nova.

For Clay, the true merit of the plan lay in the fact that it put off indefinitely the unpleasant business of settling down. There would be months of starhopping and, in the end, hope of yet another beginning.

Clay and Osgood were in the navigation room, waiting for the jump signal. Both were filled with a tingling buoyancy by the prospects which now opened before them.

"This first star," Clay was saying, "looks interesting as the devil. G 5, one-and a-half sols luminosity. It should have planets—"

"How many stars are we going to visit?"

"Maybe a couple dozen."

Lasher's voice came over the intercom. "Bridge to navigation. Ready to jump?"

"All ready," Clay replied. "Any time, sir."

There was a pause. It seemed to Clay that his heartbeat slowed. He thought: *Here we go again!*

"Jump completed," Lasher's voice came again. "Check position."

The tau-lag was seven and a third years.

They investigated the star and its system of five planets. None of the latter turned out to be suitable for human habitation. Nevertheless, the findings were recorded in detail for any future need.

The next star they visited was a red giant, the brightest star in the sky of Hell-and-Gone. Again, they collected all relevant data before moving on.

And the tau-lag was thirteen years.

And then twenty.

And then twenty-three.

And then—

They visited in all twenty-two stars. They found five planets which would support human life, two of them exceptionally earthlike. One of these, because of its similitude to human ideas of paradise, they named Eden. The other was designated as New Earth.

And the tau-lag was one hundred and ninety-six years.

Then they made two more interstellar jumps—

And the tau-lag was seven hundred and forty-nine years.

At first, they thought that the town had disappeared entirely. They floated the ship down the brilliant green path of the river valley at a height of five hundred feet —and found nothing.

They retraced their course, and that time they saw it—white walls rising a short distance out of the green. They landed.

Clay stood with Lasher, Thom, and Osgood inside the main lock, looking at the green desolation which lay before them. Creepers, bushes, weeds, and small alien trees covered the ground. The dirt they were growing in must have been deposited atop the smooth stone of the town's foundation by successive floods. The buildings were stained by flood marks. Green things growing inside them peeped out the doorways. Green life covered the roofs and hung over the edges.

Insects sang about over the foliage in looped and twisted courses. A few hundred yards away in the underbrush an animal yelped.

From any human standpoint, the place looked *dead.*

"The fact that the town is deserted," said Harry Osgood, "is not necessarily any indication that no human beings are left on the planet. In all probability, the colonists found conditions in the valley too difficult

once their atomic machinery wore out, and migrated to the highlands." He examined the map. "There may be communities on this long plateau. I suggest that we search that region first. If we find no one there, then I think the plains beyond this range of mountains would be a likely place to look."

The one remaining longboat and the ten skimmers went out, following planned search patterns. Lasher lifted the ship and landed it again beside a stream atop the plateau. And then they waited.

If there were no human beings left from the colony, their original plan would have failed drastically.

In less than two hours, one of the skimmers had found some human beings. As soon as the longboat had returned, Lasher and his principal officers boarded it and plunged into the stratosphere for a ten-minute flight that took them to the spot on the northern end of the plateau where the skimmer was still trailing its find.

From an altitude of one hundred and fifty feet, they didn't look too bad. There were about two dozen of them, all astride huge six-legged creatures which were covering ground at about forty miles per hour. Those animals could gallop! Hoofs the size of dinner plates were thudding against the earth in an easy, powerful rhythm; thick necks and long heads of a grass-eating species were straining forward.

Clay studied the men. They were tough-looking specimens dressed in animal skins. Their clothing consisted uniformly of baggy jackets, loose, knee-length pants, and tight leggings. They wore no caps and their long hair blew back in the wind as they leaned forward low on their mounts. They carried spears or javelins and some of them had bows and quivers of arrows.

"Perhaps," Harry Osgood said, "there are more advanced groups somewhere else on the continent. Even these people seem to have developed a culture in response to the plateau environment."

From the way in which the barbarians below looked up at the longboat and the following skimmer, they were terrified. They probably thought they were being pursued by demons or something.

Presently a village of skin tents came into sight. There were about fifty of the things, which might mean a population of near three hundred. The desperate hunting party thundered in at full gallop, shouting explanations and orders as they came. Men, women and children boiled out of the tents like hornets out of a disturbed nest. Stones and arrows came up to meet the longboat.

Lasher studied the scene below and ordered technicians to take photographs. "Well, Osgood," he asked, "what do you think?"

The wizened little starman peered fascinated through the port. "Apparently a nomadic culture," he said. "Since we haven't seen any herds,

we can assume that they're hunters. This is also borne out by their extensive use of animal skins in clothing and in making their tents, as well as by their choice of weapons. That classifies them. Nomadic hunters. Hm-m-m."

He pursed his lips. "Cultures of this type," he went on, "as a general rule do not progress. Once they're achieved, they remain arrested—static—until force of circumstance breaks them up." He rubbed his forehead with two fingers. "It looks as though we may have to take a hand in the development of these people."

They found, in all, seventeen communities of the nomads upon the plateau. The average population was between two and three hundred. There was an essentially uniform culture for the entire region.

In the following week they found more communities on the plains beyond the mountains. These people, too, were nomadic hunters, although they differed somewhat from the plateau tribes in style of dress and weapons.

"In time," Harry said, "they will be forced by population growth or some other physical challenge to turn to agriculture. In that case we could expect some kind of technological civilization to develop in . . . say . . . several thousand years. But I think that the transplantation idea is sound. It would in any case give us another string to our bow."

So the longboat swooped down one dim purple dawn on a village of the barbarians, its heavy, wide-dispersion stun-charge projector firing—and the *Gibbs* lowered out of the starry zenith to land near the little cluster of humped tents. Crewmen carried the unconscious hunters and their families into the ship on stretchers and loaded their tools and weapons and food stores.

And as the sun rose the great ship lifted for space and the stars.

The *Gibbs* lay inert in the deep heavens some fifteen hundred light-years from Hell-and-Gone. Clay was immersed in the task of computing the direction-line that would take them back when he suddenly had one of those flashes of insight which Daniel Kerrigan had been wont to call "metaphysical awareness." He leaned back from the star-filled scope and let his eyes unfocus as the mood took possession of him.

For a brief while, he saw himself here, working at a job as strange as any ever attempted by the sons of Adam. He saw his life in the Interplanetary Corps and the Interstellar Service, living in a dome on Mars, sitting in the base music room at Hudson Valley, working here in the *Gibbs'* navigation section, riding thrice to Beta Hydri and once on the far course to the Nebelnest—many times and many events, all lit by a kind of magic or fantasy.

This was *his* life—not a bad life at all.

They had planted that first tribe

of captured barbarians on the golden plains of an autumn on Eden, and the second beside the waters of a bay on the coast of the largest continent on New Earth. When they returned, the tau-lag would be over three thousand years. In that interval whole cultures would have risen and disintegrated, and many a great ruler would have gone from dust to absolute power and back to dust again.

They hoped, on one of the three worlds, to find technological civilization. These starmen were in a peculiar situation. Presumably, they would keep on starhopping until they found a culture advanced enough for their purposes, and then would settle down to being ordinary spacemen again. In the meantime, they played the parts of gods.

Like gods, they had swooped down on defenseless villages of the nomads and carried the populations over parsecs to other worlds. Like gods, they waited millennia to view the results of their experiment. Mere human beings were born, struggled their span, bred and died on their little worlds—ignorant, unknowing. They were little more than molecules whose statistical interaction gave validity to Harry Osgood's historical analyses. Out here, far in the deep heavens, the gods bided their time, waiting patiently for the millions of molecules

to play their parts and produce the expected result. They came and passed, again to come.

One day, presumably, they would become ordinary human beings again. But Clay couldn't help wondering, because he saw that the starmen weren't really counting on that. They hoped to find a technological civilization where they could resume their old work of ferrying colonists; but if they did not, it was no matter. They had not chosen this plan because of any feeling of duty toward the human race; they had not taken this gamble in the hope of discovering in the future a culture they could join. They didn't want to join any culture.

They just liked playing the parts of gods.

The town straddled a river, two stone bridges connecting the opposite banks. The streets were narrow and filthy and the outlandish wooden houses looked dingy even in the mellow afternoon sunlight.

But steam-powered boats were moving up and down the river, their paddle-wheels churning the water to muddy foam. A factory's chimneys rose south of town, pouring out smoke as a visible evidence of industry. One of the dingy buildings in the town housed a printing shop, and two others were fitted out as university classrooms.

The place showed promise.

"People form a culture," Harry said, "when they're faced with a challenge. The challenge must be severe, but not too severe. And it must give rise to further challenges.

"On Eden," he explained, "the challenge wasn't hard enough. We saw the result—barbarians living on the fruit of the land with little effort and a primitive, static culture.

"Here"—he waved his pipe at the town—"on New Earth the challenge was about right. These people are going places. They already have a respectable mechanical technology, and they seem rather precocious politically. It's almost unheard-of to find a culture at this stage with world government. With the head start in electromagnetics and atomics that we can give them, they'll go far—and fast."

It had taken them a month's intensive effort to learn the language well enough to communicate. Then had come the exchange of information, beginning with Captain Lasher's history-making words—

"More than two thousand of your years ago, we placed your ancestors upon this world."

The D'latolians, as they called themselves, were satisfyingly amazed. When Lasher went on to explain that they had all come, some thirty-five million years before, from a world so far away that they could not conceive such distance, they were frankly incredulous—but impressed.

At long last, Lasher had released the group of original colonists who, because of illness, had been hospitalized in the ship when it left Hell-and-Gone. Felix had already explained the situation to them. Be-

wildered but hopeful, they set about learning the D'latolian language. They would remain on New Earth.

Clay surveyed the grimy streets and houses with dissatisfaction. "Well," he sighed, "I guess we've finally found it. We can help these people a lot. How long will it take to raise them to interstellar-level civilization, Harry?"

Osgood lit his pipe and puffed on it to get it started. "Maybe . . . maybe a hundred . . . maybe two hundred years."

Lasher glanced sharply at him and frowned. "We have a duty towards them," he said. "We've got to help them. But in my opinion the job can wait a while—until they've gone a little farther on their own. We can do some more star-hopping in the meantime."

"Maybe," Harry replied. "I think we should teach them some of the elements of our technology in any case."

Felix interrupted. "I've been sounding out the crew," he said. "A number of them are in favor of remaining here. They're tired of living in space, in an artificial environment with no women. The obvious thing to do is let those stay who want to—and take the ship with the remainder of the crew. We can drop over to Hell-and-Gone and see how things have been getting on there the last three thousand years. In the meantime, the group here can be teaching the D'latolians how to generate electric current and so forth."

"Good!" Clay exclaimed, feeling immensely relieved. "I like that. It takes care of everyone."

The captain slowly nodded his approval. "That's what we'll do," he said.

Lasher gave the crewmen a month's vacation before leaving D'latol. They needed it. It was nearly four months by ship time since they had left Earth. Clay and Thom and Osgood had a magnificent saturnalia. They visited all the night spots in the city, poured D'latolian wine down their gullets in quantities that brought looks of frank amazement to the faces of onlooking natives, and roared through the dark streets at dawn howling out unprintable songs fifty million years old.

Nobody minded. Lasher, while not himself of the temperament to engage in such excesses, was accustomed to the habits of starmen on leave. The D'latolians were amused and gratified by this final conclusive proof that the godlike visitors were indeed human.

By takeoff day, Clay and his friends were ready to call it quits. Men cannot live in idleness and dissipation forever. The morning came when they knew to the depths of that last hangover that it was time to shave and put on clean uniforms and sober up. They did.

Thirty-two men chose to remain on New Earth. For Clay, takeoff was the old familiar blend of heartache at leaving men he liked and

intoxicating joy at prospects of far horizons opening ahead. The crew, reduced now to a third its original number, marched aboard ship. Lasher said a formal farewell to Radrickuw, Major Domo to the Emperor, and promised that the *Gibbs* would be back in a couple of hundred years. Radrickuw was patently awestruck at the notion.

Then they lifted into the serenity of space and the stars.

Completion of that twenty-seven light-year jump found them a hundred and thirty million miles from Hell-and-Gone. They started the planetward run. Felix and Harry were in the navigation room, keeping Clay company.

"We've done pretty well by the human race," Harry said. "We've created an island of human culture out here in the Nebelnest, and given it the fundamentals of terrestrial technology. You know—we, and the people on the three planets we've colonized, may be the last human beings left in the universe. Fifty million years is a long time. Out here, the race can start all over again."

"Don't feel so saintly," Clay said. "You know we didn't do all that from any sense of duty. We just liked the idea of starhopping around and waiting to see what those colonies would do. We just liked the feeling of being History Makers."

"It seemed like the thing to do at the time," Felix murmured.

Brrraannnggg! !

Clay hit a stud on the control panel and the meteor alarm ceased its clangor. He threw a switch; the lights dimmed and the viewscreen came on. They showed stars and a bright-ringed black disk that was the sun. One of them held an image of Hell-and-Gone, a brilliant spot of light at ten million miles.

And all of them were marked with scattered moving red glows.

Something was seriously wrong. The meteor-guard system was designed to react automatically to bodies moving on collision courses with the ship, changing the ship's course to avoid them. The alarm meant that there were too many ob-

jects riding collision orbits for the system to avoid.

There wasn't any asteroid belt in this system.

Clay swore and pulled an emergency switch that activated the heavy Hemmingsen guns, putting them on auto-fire. Red glows began winking out.

Through the scope, it didn't look so peaceful. There were flashes of light so brilliant that they hurt his eyes. A hundred megawatt beam hitting meteoric rock or iron shouldn't make so much light.

Those weren't meteors.

"We're being shot at," Clay said.

He could imagine the situation. In three thousand years men on Hell-and-Gone, finally breaking free from the nomadic pattern, had rediscovered civilization—rediscovered electricity and atomic energy—and reached the planets. Somewhere along the line they had had to do a lot of fighting. They had developed methods for waging war in space.

Suddenly a huge spaceship—the *Gibbs*—had appeared out of nowhere and had made directly for the home planet. They were shooting first and asking questions, if any, afterwards.

New red glows were appearing on the viewscreens all the time. They were appearing faster than the automounted Hemmingsens could destroy them. Suddenly some of them began flashing yellow—the one thousand mile signal. Clay made a convulsive movement toward the drive control, then stopped. It would take minutes to charge up the accumulators, longer than usual with the Hemmingsens drawing so much power.

They couldn't jump out.

Clay envisaged long dark spaceships lying out there, a hundred thousand miles or more distant, atomic-armed attack rockets tumbling out of launching gates in their sides and streaking away under high acceleration, robot controls set on the *Gibbs*.

Felix Thom stood, face red and great fists clenched at his sides, helpless. Harry Osgood held his pipe in his hands; his lips were compressed, his eyes fixed fascinated on the screens.

The yellow glows increased relentlessly.

There was a momentary impression of great light and heat and violence . . .

A wild jaunt into the unknown, a soaring into the mystery and chaos of existence—this is the privilege, duty, and fate of the intellectual hobo, the bearer of the torch who did not strike the match and will not see the bonfire, but is engaged in a perpetual marathon between the past and the future.

THE END

THE CONROY DIARY

BY RENÉ LAFAYETTE

***Fascinating** yarns, the guy told! Phony, of course—but they were just the sort of romantic nonsense to appeal, to make space-wanderers come out from Earth! Except for one minor point—*

Illustrated by Brush

It is with considerable surprise that the researcher into ancient and forgotten lore first encounters the "Conroy Diary". Inevitably, if he neglects the foreword before perusing the text, he is startled by the flamboyant style, the indelicacy of the anecdotes and the altogether royal presence of mind of the redoubtable Conroy. He will look hurriedly for explanation in the beginning and find it.

"Dear reader," the foreword of any original edition will say, "do not be too amazed by the brilliant exploits of our dashing hero. Conroy, alas, lives only in the mind of Fitz Mallory, his creator, and any resemblance to persons, places and planets is purely extraordinary and probably fortuitous."

It is well that the diary so begins. It was a work of fiction written by one of the most remarkable characters Earth ever produced, the fabulous Fitz Mallory.

In a day when adventure languished and the life of man seemed trite, Fitz Mallory came upon the scene as a God-given boon to mankind. He made an entire generation rock with laughter and gape with amazement, and, what is far more important, Fitz Mallory sold the idea of space conquest to the human race.

Mallory's inevitable good fortune was something of a legend. He was a man of inexhaustible resources, material or mental and he lavished both upon his race with a hand so prodigal that, once, he nearly wrecked the economy of the United States, a nation of the original Earth.

Since Mallory's time our race has produced richer and more powerful men, gaudier or more important fig-

ures. But none of these people ranked him in the service he performed. In the ensuing hundred thousand years people still recalled Mallory even when they had forgotten his book.

"Conroy's Diary" makes wild sport of every accomplishment known to man and it particularly plays the buffoon about space travel. To quote it is no purpose here for it can be found rather easily in the libraries of any major galaxy. To tell the story of Fitz Mallory is the thing which needs to be done. He was not, as so many school children seem to believe, a god of an ancient mythology. He was a flesh and blood man. Crowned, perhaps, with more than his share of luck and wit, he still had his mortality. His tomb in the Earth National Park is a popular shrine and few days pass when fresh flowers or wreaths are not hung about it by some individual or organization. It is surmounted by a statue of Mallory, life-size, garbed in the space gear of that time, his head back in a magnificent laugh. The several times it has been

restored have distorted the features a trifle, the garments are a bit chipped, but the laugh is still there. He is indeed Fitz Mallory, Crown Prince of Space.

In piecing together this remarkable man's life, the historian is quickly struck by the absence of actual facts. So coated, buttered and floodlighted is the reputation that to discover the man under it is difficult.

He seems to have begun his career in an orphan's home and the record appears to be entirely innocent of proper schooling. But there were not and are not schools to teach what Mallory had to learn.

At ten he was with Krinsky on the Pluto Expedition. Just how he got there is obscure but the logs of Krinsky carry continual mention of a mascot he calls Mr. Luck and it can be assumed that this was Mallory. According to these records and the news stories of the expedition, the fifty-man company found itself to be fifty-one the first day out or, as Krinsky says, fifty and a half.

If he did anything on Pluto, Mallory himself never seems to have mentioned it. But it was one of those fortunate expeditions which sail smoothly along a careful plan and all fifty and a half returned.

At fourteen Mallory deserted civilization again in favor of the Roberts Rescue Expedition which took the bodies of the ill-fated *Lombard* off Saturn. The sight of the bodies does not appear to have damped Mallory any for at seventeen he is to be found aboard the *Golden Lion* on the Mars run as second mate, or so the shipping records of the day declare.

It is remarkable that, with all this data from which to draw, Mallory never wrote a line about the Solar System. And it was equally remarkable that he signed off the *Golden Lion* when he was eighteen and did not again appear in any record until he was thirty-one.

Then Mallory becomes, suddenly, Mallory the great, the darling of Earth. He wrote a book. It was about the mythical adventures of an outrageous man named Conroy and it was rapidly banned by all societies for the prevention of vice. The book was about a hundred thousand words in length and it purported to tour one Conroy on several voyages to various star systems wherein he dueled with dragons and got drunk with the daughters of humanoid kings and was deified or jailed as the popular whim might dictate. But whatever happened to Conroy he was always the victor, always the hero, always loaded with the favors of damsel and king and Conroy always said so.

The book came after two government expeditions had gone out to Alpha Centauri and found humanoids. Their reports sounded so ridiculous and the work itself was so comparatively useless that Man was in a mood to laugh. And at that psychological moment, in step-

ped Fitz Mallory's "Conroy" and mankind roared with mirth.

According to the memoirs of a Captain Sauvage, the Explorer's Club was officially stern but unofficially very amused.

Sven Durlinger came there, one quiet Sunday afternoon, on a search for Mallory and he found him.

Mallory was a big man, very good to look upon, tawny haired and strong. He had a group of thirty or forty members and guests hanging on his words, already laughed into exhaustion and ready to laugh more.

"But how," pleaded a young man, "did Conroy ever get out of the dungeon?"

"There's no law against kings having daughters, is there?" boomed Mallory. "And while it is true that she had three heads, Conroy knew instantly that three heads are better than one and . . . hello, Sven!"

"Hello, Fitz," said Durlinger. He was a small man, the navigator and chief pilot of the Allied Survey Expeditions. "Don't let me interrupt you."

"Not at all! Come over here and have a drink. Boy, go find Mr. Durlinger a drink. I heard you've been looking for me."

Sven nodded. "It's kind of public here."

"Fire away!" boomed Mallory. "I have nothing to conceal. I hope."

"Well," began Sven diffidently, "it's kind of trying to come back after a year spent in a vacuum to find the whole world laughing about space travel."

"Now, Sven. You're not mad."

"No. I guess not. But it's upsetting. We worked like the devil around Alpha Centauri. And we didn't get out of any dungeons with the help of the king's daughter, either. I thought you were a friend of ours."

"I am. I am!"

"Mallory, you've put back space travel fifty years. Every new thing that comes in, somebody will snort and say that Conroy should have found it. It's very difficult to bring people to realize just what a spanking big Universe that is out there and how many various things there are in it. They were laughing already without the help from your Conroy. We have a flying dog—"

The whole crowd laughed. Sven shrugged. "You see. Even you salty characters are ready to classify straight out of that confounded diary. We really do have a flying dog. Space exploration is serious stuff, Fitz."

"Drink up," said Mallory. "It will make you feel better."

"When you and I were with Blanding on the *Golden Lion,* you were dead serious about all this. You yourself said one night that man's only salvation lay in the stars. Why kill it?"

"Sven," said Mallory, "just what did your expeditions prove that hadn't been proved already? Nobody on the whole planet is going to sail off and stake out a homestead

on Lincoln of Alpha Centauri. We have our fun, let them have theirs."

"Speaking of fun," said Sven, "where *have* you been in the last ten years? You don't seem very out-at-elbows. Or is that the book paying royalties?"

"Well, as for that," said Mallory, "I got me a small loan from Conroy."

They all laughed and when Mallory had told them just how Conroy had got the capital which furnished the source of that loan, they laughed harder. It had to do with selling a necktie, which lighted up, to a certain medicine man on some weird planet of which no one had ever heard. Then Mallory took Sven out of there.

They rode uptown to Mallory's apartment and there they found the butler waiting and the cook with dinner ready and Sven stood around and blinked. This apartment must be worth two or three thousand a month and the furniture was capable of paying a few ransoms. Did books make this much money?

Sven mellowed out a bit under wine and what passed between them at the table is no matter of record. Sven went away the next day and was not seen again for an entire year.

But whatever happened to Sven Durlinger, it could not bother Fitz Mallory. Nothing ever bothered him. He went on his princely way, attending levies, autographing books, smiling on old ladies and young children and spending lavishly far beyond whatever his means could have been.

At the Museum of Natural History in New York, Earth, there is a copy of a speech made by Mallory on the occasion of opening a new wing. They did not intend to have Mallory speak, for the occasion was solemn. There was to be a new exhibit of fauna and flora from Lincoln, Alpha Centauri and there were many additions to the Mars-Venus displays.

The Curator of Other Worlds was astonished to read in the morning press that this afternoon Fitz Mallory was to speak there. Ordinarily he would have instantly protested but it happened that he knew Mallory and one does not usually offend men who are six feet four. He held his peace. At two o'clock he was doubly astonished. The hall, which held four thousand, was packed and people were piling up in the streets. This dazed him. A five hundred person attendance would have been remarkable.

He was wringing futile hands and wondering about the courtesy of turning so many away when a rigging truck drew up and eight communications men plunged through the crowd which was piling up in the street to install a dozen speakers and a huge visio screen so that the overflow could see and hear if it filled the entire park.

It did fill the park. Mallory came, leading a strange looking animal with six legs, a huge head and

horns about twelve feet long. Mallory solemnly led the brilliant pink beast into the hall amid thundering cheers.

The curator made his pathetic little address about his new hall and then helplessly introduced Mallory.

There ensued a rapid-fire, booming lecture, a solemn-voiced atrocity of hashed up Latin and mangled zoology in which Mallory exhibited the curator by mistake as a specimen taken on the planet Jungo-Boola of the System Gastric, caught after three hundred humanoid beaters had lost their lives. Mallory recognized his error and humbly apologized and then absent-mindedly began a flora speech on a potted palm which had been on the platform there since time had begun. Its deadly poison was the result of a malevolent eye which grew in the center of the tree, he said, and the already laughter-weakened audience shrieked when the president of the museum rose with haughtiness from his seat behind that palm.

The *piece de resistance,* however, was the six-legged alihipidile from far off Bingo-Bocbum of the Roulette System. This ferocious beast used its horns to spear doughnuts and lived on a diet of mink coats which made it expensive to keep. However, for the benefit of the assembled, Conroy himself had brought this beast all the way from far off Bocbum at great and terrible expense and only that morning had had to take donations on Fifth Avenue to make up a proper ration. If any showgirls were in the crowd— But at this point the six-legged alihipidile revolted and began to buck and suddenly came apart into three men and a hide which caused such obvious embarrassment to Fitz Mallory, who reviled the absent Conroy, that it broke up the show.

About a month later the Geophysical Society found that it had scheduled a meeting it did not know about when the curious members attended Carnegie Hall which had been rented for the night, admission free, they were stunned at the vastness of the apparatus strung about the stage. They did not understand anything about this until Fitz Mallory, tawny and laughing, came upon the stage and greeted a packed hall with the news that tonight he was going to show them the newest inventions for space travel.

There proceeded a display of scientific mumbo jumbo which made the audience scream and the Geophysical Society squirm. Folding spittoons, self-disposing rations which did not have to be eaten, a flamboyantly introduced new ship heating unit which turned out to be a slinky brunette and other items rapidly reduced the sanity of the crowd. And then Fitz Mallory demonstrated the newest and greatest invention of all. It was a gravity shield, he said. And he slid a piece of the material under him. Promptly he began to drift off the floor, noticing the fact so late that he had a terrible time shifting over

to get down again. As he lectured he absent-mindedly kept stepping on the shield and rising and finally, as his lecture reached its climax, stumbled across it and promptly soared straight up and out of sight. A few seconds later he was coming down again but he was angrily arguing with the man in the wings who was working a reel and fighting to get loose from the wires which were harnessed to his coat.

It ended the breath of the audience and the show.

But although the publishers of the book were delighted with these things, the scientific world was not. Fitz Mallory had stepped too far when he had billed Carnegie Hall as he did. He was thrown bodily out of the Geophysical Society. The Explorer's Club was far too tolerant to take action but it became cool.

The Society for the Exploitation of Space, very old now and staid, struck Mallory from its list and recommended that the government take some action. The government did take action, but not of the expected kind.

For a year Fitz Mallory had been spending money. And he had made no income tax return. Conroy, romping through further adventures in a second book, had obviously brought in more money than the publishers reported having paid Mallory.

Two investigators, working quietly, found that Mallory had spent, one way or another, something more than a million dollars during the year. They had the facts and, shortly, they had Fitz Mallory.

They interviewed him politely in the Collector's Office, politely as befitted a man who must owe them a million and probably more.

It was the third of May of that memorable year. There had been murders and robberies and a senator slain in a love nest but the headlines all talked about Fitz Mallory and the government.

"WORLD'S GREATEST LIAR BAFFLING GOVERNMENT" is a sample of these scareheads. If war had been declared, no greater stir would have been made. Everybody waited to hear about this one. The papers repeated past exploits, including the latest, a fiasco wherein Fitz had been exhibiting the largest dwarf ever caught on Flub-Mub of the Sambo System, a person some eight feet tall known to anyone who had ever seen a jungle motion picture as Sam Casper of Sioux Falls.

"Mr. Mallory," said the collector, "you must have some accounts of your transactions and some explanation of your income."

Fitz sat back and counted thoughtfully on his fingers. He made some secret figures on a piece of paper and destroyed it. He pulled out a slide rule and slaved over it. Then he drew out a pocket adding machine and worked with it for ten breathless minutes.

Finally he said, "Nope."

The collector was stern. "Mr. Mallory, I must warn you that un-

less you divulge your sources and explain yourself satisfactorily, we are prepared to send you to prison."

"On what evidence?"

"We have received secret information from an anonymous but identifiable source to the effect that your income during the past year was more than a million dollars. All but twenty-nine thousand of that is, of course, tax."

"A secret informer?"

"Yes, that is the case. I have the affidavit here."

Mallory seemed to deflate. He looked very sad. "I shall have to get my books. It will take me almost a week. You won't send me to prison, will you?"

"Unless you pay, frankly I have no choice."

Fitz went out and found the street jammed. Cameras flashed, people cheered. Reporters tried to learn something. Mallory pulled out a tin cup and a pair of dark glasses and sat down on the steps, putting up a sign, "I got to pay a tax. Please help the needy. Conroy is out of town."

During the week Fitz made several volunteer lectures on the fauna and flora of the Treasury Department. He offered land for sale on the Planet Slumgo of the Blue Sky System, a billion acres of it at ten dollars an acre. He had an atmosphere ship paint a huge sign over New York, "S O S Conroy. All is forgiven. Come home. Mallory. P.S. I need a million dollars." This was in reverse as it would be addressed to some star.

Meantime the press kept asking, "WILL MALLORY GO TO JAIL?"

And the Collector of Internal Revenue kept replying, "Yes. Unless."

The week was finally at end. Fitz Mallory delivered himself up.

Solemnly he placed a dozen ledgers on the desk of the collector and sank wearily down. Reporters had been admitted at Mallory's request.

"This is no sideshow," warned the collector. "I am sick of this buffoonery. I do not care a straw about popular opinion. I am doing my job as I have been ordered to do it and I have no other choice." This, delivered to the reporters, was properly noted.

The collector approached the ledgers. He opened the first one. The top entry was, "Full price for the Planet Slumgo, $100,000." The next read, "Loan repaid to Moolamaun, King of the Tarkabs, $10, in beads." The following was, "Ransom of Miss Geeber, cut price, to her friends on Kaledon—price cut for certain considerations, $1,000,000. In diamonds."

The collector slammed the ledger to the floor. "I have been used long enough for publicity to sell books! These are no accounts. You have no sense of decency! Mr. Mallory, I cannot permit this to continue. Produce your sources of revenue—"

There was a slight commotion at

the door and a man walked in. He was clad in a tattered spaceman's coat and belted about with a scratched stomach protector. He was unshaven and he was tired.

The collector glared at him for the intrusion. "And who the devil might you be?"

"I am Sven Durlinger, lately chief of the Recheck Expedition. This is my friend, Fitz Mallory. I understand that there is some trouble here about income."

"Trouble enough!" said the collector. "And enough that you needn't add more."

"Sir," said Sven quietly, "I can testify that Fitz Mallory's income from his books was bequeathed to various charities. I have seen the records and I know the charities."

"Who are you to testify that?" demanded the collector.

A small man in the rear of the room, an attorney for the publisher, came forth with an imposing book. On inspection it disclosed that not one penny of the sales of the "Conroy Diary," volumes one and two, had been given to Fitz Mallory.

This was curious enough. What followed was worse.

"Fitz Mallory," said Sven Durlinger, "is a firm believer in the future of man in space. He should be. He made enough money there." Sven turned to the reporters, "Gentlemen, Fitz Mallory is a fraud."

This was not news.

"He is a fraud," said Sven Durlinger, "because he has written the truth." He unrolled a long series of photographs and beckoned up a young space officer who had a pile of documents. They were strange photographs. They were stranger documents.

As the collector made his inspection, Sven continued. "Gentlemen, for the past year I have been retracking. I have visited twenty-three planets in various systems, all of them habitable, seventeen of them inhabited by humans or humanoids of which you already know something.

"You will not lightly disregard my word, gentlemen, nor my evidence. I have a twelve-man crew to back me in everything I say.

"Fitz Mallory is a fraud. He has visited every one of those planets. He gave some of them outrageous names and he treated them all to outrageous adventures. He is considered a god on a round dozen of those worlds and a mention of his name was enough to bring kings kneeling at my feet. He is a fraud, gentlemen, because he is masquerading. There before you, and look at him well, is Conroy!"

The stillness of the room attested that nobody was breathing. Not one eye blink fanned the air. They gaped at Sven Durlinger.

"For ten years, in the old *Liberty III* which was given him by the great Krinsky on that man's death, Fitz Mallory cruised space, plotting the way, mapping routes, inventing means. The 'Conroy Diary' is truth told with a flare. What man would have believed it as fact?

Who believed in space travel? From ample evidence received on the ground, I am prepared to attest that the majority of adventures which befell the mythical Conroy actually happened to Fitz Mallory.

"It rocks your wits, I know, to understand that this man is no clown. He carried forward a complete plan to credit space travel to everyone. He returned here from his last voyage, resolved to counter the usual rebuff. He countered it with the diary. You have all read it I am sure. It is true, gentlemen. True as sunlight! And the ledger I see open there on the floor must be a true ledger. The third item I know for a fact. I am afraid, Mr. Collector, that you have the wrong man."

The collector was sputtering now. He finally managed: "But this is no rebuttal of my charges! What do I care—"

"Indeed, I am afraid it is," said Fitz Mallory with a big grin. "That money was made out in the stars. All of it. It is exterior income for I am no resident, being an international citizen. Excuse me, sir," he said rising, "but when I sent out Sven, I had a mission to perform. I have used you harshly, I fear."

"But the affidavit!" cried the collector. "The affidavit!"

"I wrote it," said Sven. "And Fitz mailed it to you as a report on himself. We are only interested in one thing—space travel."

"There's a charge for that," said the collector. And then, suddenly looking at Fitz, "Say, wait—you mean those Conroy tales are all true? You mean a man can have adventures like that out in space?"

"I am afraid so," said Fitz. "It's a rough life but a merry one. I am leaving soon on my next voyage. I could use a man like you."

"Could you?" said the collector, pleased. "I'll go!"

The papers ran it as it was played. There was a raging hurricane of argument throughout the world in the next few days. Fitz Mallory was discussed in half a hundred languages.

The world was laughing at itself. And it was laughing with Fitz Mallory, the god of a dozen habitable worlds, the owner of stars, the Crown Prince of Space.

He never wrote another book. He did not have to. He went away soon after to plot more routes.

They brought back his body some thirty-two years later. He had landed on one too many planets as all spacemen did sooner or later. They built him a big tomb and a famous sculptor made a statue of him with the most imperishable materials at hand.

Fitz Mallory still stands in gray obsidian, surrounded by flowers and offerings even today. His head is thrown back in a huge laugh and the legend on the base states:

"Fitz Mallory. God of a Hundred Worlds. He opened the Universe to Mankind."

THE END

BRASS TACKS

Sorry, Derleth—guess Ted's having trouble with his finger counting!

Dear Mr. Campbell:

May I offer two corrections to Mr. Sturgeon's fine review of "Strange Ports Of Call"? The price of the book is $3.75, not $4.00, and contrary to assertion, there are five, not two, stories from Astounding in the book—"The God-Box," by Howard Wandrei, 1934; "At the Mountains of Madness," by H. P. Lovecraft, 1936; "Far Centaurus," by A. E. Van Vogt, 1943; "A Guest in the House," by Frank Belknap Long, 1946; and "Thunder and Roses," by Theodore Sturgeon, 1947. —August Derleth, Arkham House: Publishers, Sauk City, Wisconsin.

That annual has a six-months sales date. Give us time; you'll be told!

Dear Campbell:

Shades of Abe Linclon! "Bureau of Slick Tricks" is just that! Reminds one of the good old hoss-trading days. Same type of unethical ethics carried to a hilarious extreme by Fyfe. (Kuttner?) As good as you hinted.

"Genius," as indicated by Anderson, was also carried out to nearly ultimate potential. Some kind of a surprise punch was a natural expectation, but when it came, it was at unsuspected angle. Excellent stuff.

"Late Night Final" was a gem of pure escapism; and though we have had previous glimpses of the same precious stone in stories like Williamson's "Equalizer," and Stuart's "Forgetfulness," still—who's complain'? Not I, certainly.

And Part the Third of van Vogt's "Players of Ā," though loosening up a little on the suspense, seems, in ways, much superior to "World of Ā" in clarity of concept. Marvelous job of writing in vV's way.

In Brass Tacks, I am inclined to agree with Blade on Williamson.

". . . And Searching Mind" in nomination would get my vote, too, for one of the all-time-bests. It was tantalizing of Jack not to go farther in tying in the newly recognized supra-conscious factors of the psychic senses; but even hints are enough to enthuse me. I hope he will pursue these lines later on. How I hope it!

A thousand cheers for the Unknown Anthology! "The Enchanted Week End" happened to be in an *Unknown* I'd lost while moving, and to have it replaced thusly seemed a wonder above wonders.

When *will* we get news of *Unknown's* revival? This holding of our collective fan-breaths is uncomfortably wistful, and wishful. . . .
—M. J. Nuttall, Rt. 1—Box 601, Lakeside, California.

There are good things on the way for '49. Old hands back—new recruits coming!

Dear Mr. Campbell:

The December issue was very good, in fact, were it not for Orban's poor cover, it would have been the best issue of the year. It's too bad, because the insert on the cover is very striking and is good art work —the colors are excellent and must have been tough to reproduce in producing the magazine. But that spaceship ruins it. As several other letters to Brass Tacks have mentioned, Mr. Orban does not draw good machines or spaceships. The interior art is fine, as usual.

ANLAB:

"Players of Ā," by Van Vogt is first. Better and better as it goes.

"Late Night Final," by Russell is next. Idea reminiscent of "The Warrior Race" (1940) but this one is much better written than the Race.

"Genius," by Anderson. A new writer, and a surprise ending.

"Bureau of Slick Tricks," by Fyfe. Cops and Robbers.

Review of 1948:

"Players of Ā," Van Vogt. The best of the best.

"Now You See It," Asimov. Good to see him back.

Let us have more of him, please.

"And Searching Mind." Williamson develops, or better, comes of age.

"The Rull." Van Vogt again. Just like in the good old days of 1941-1945.

"Smaller Than You Think." Gray, a new writer and a new idea on faster than light travel which is sharp thinking.

"Time Trap," Harness. Another new man and another good story. One of the few time travel stories I like.

"Love of Heaven:" Sturgeon scores again with another powerful story. The ending leaves the reader thinking of what comes next.

"The Monster:" Van Vogt again, which is what I like.

"That Only A Mother:" Beauti-

ful writing by Miss Merrill on her first ASF story.

Best Cover: May 1948 by Alejandro

Worst Cover: December 1948 by Orban

Best Issue: August 1948

Worst Issue: March 1948

Comments: The return and fine showing of Messrs. Van Vogt, Asimov and Sturgeon is very gratifying. The large number of new writers is a good sign for the future of the magazine. The superlative work done by Alejandro and Bonestell needs no further praise.—William E. Dorion, Ens. SC USN, NASD, Philadelphia, Pennsylvania.

"In Hiding" was a genuine smash hit! And re the unreality of the "Battle of the Sixth Decant"; remember that here in the United States, the landing at Normandy, the battle of Iwo Jima, were all unreal—type laid on newsprint, six pages ahead of the comics, less immediate than the lost ration book.

Dear Mr. Campbell:

Doubtless you are not surprised to see another letter coming from this hack, yours truly, but I simply have to unload science-fiction on somebody, and you seem to be my only hope. So here goes:

The November issue was entirely adequate, wonderful in spots and thoroughly satisfactory everywhere. Most of it was really enthralling, but the endings of some of the stories detracted from their effectiveness. Here is my rating:

1. "In Hiding:" This was wonderful, an absorbing interesting and thrillingly original piece of work on a subject (The Mutation, also known as Homo Superior) which has been handled effectively but on such a dizzying plane by van Vogt and others in times past but which has never before, to my knowledge, been presented so simply and clearly, in such a down-to-earth fashion. After all, the mighty events of our glorious future will have their effect on the solid substratum of average men and women, such as are represented here by Tim's grandmother and Peter Welles. I know that E. E. Smith is doubtless very busy now working on some new and mighty science-fiction conception, and wouldn't do such a thing anyway, but I still wish that somebody, who had nothing better to do, would write an account of how John Q. Public felt about the intergalactic war with Boskonia. Some of this sort of thing here and there might make the predicted future seem more real to Astounding's readers.

2. "The Players of Ā" (II): I have now read "The World of Ā" and reread Part I of this new serial, so now I think I know what is supposed to be going on. I place this serial second in this month's rating because a real galactic novel is a welcome sight for sore eyes, but I still don't like it too well. The

reader has a feeling of being shut in and confined, seemingly inside Gosseyn's extra brain, while watching helplessly, just like Gosseyn, for the next move of the "cosmic chess player." Such tremendous events as the Battle of the Sixth Decant, which runs on and on like a phonograph needle stuck in a record, remain only something seen through a visiplate, not the living, titanic reality that a space battle can be. Instead of a grand organization of intelligent entities fighting and winning their war against the encroachments of tyranny, we have a whole galaxy, with all its worlds, represented as only a pawn on a colossal chessboard, which can be saved only by the sole action of one man. Gosseyn can save the galaxy only with his brain, but this instrument of power keeps jumping from body to body like a demented jackrabbit. I always thought chess was a rather dull and discouraging business anyway.

3. "Expedition Mercy:" Well done. It seems good to have a writer who at least knows his medicine. But why, oh why that insane ending? Have we a series? If so, this story is indeed an odd beginning for it.

4. "The Love of Heaven:" This was adequate enough, but there was too much time spent on the man and his dog and too little on the mighty story of the intruder. Besides, I have never liked stories of such utter and final failure.

5. "Period Piece:" Even this was averagely good, but contained such an odd jumble of facts and impressions that one's final impression was permeated by confusion.

Both articles were marvelous, among the best I have ever read in Astounding, and the editorial was even better. Let's forget the now dull topic of atomic energy for a while, Mr. Editor, and turn out more gems like this. (And may I add my plea, with fervent emphasis, to the entreaties of other readers in asking, where is Don Stuart these days?) The book review was fine. I must lay my hands on that book as soon as possible. Until next month, more power to Astounding and E. E. Smith!—Warren Carroll, South Berwick, Maine.

An extremely good short essay on science-fiction art that should start quite a discussion. Recommended reading for science-fiction artists and would-be artists!

Dear Mr. Campbell:

"To know how to criticize is good, to know how to create is better."—H. Poincare.

The above quotation, as you probably know, is contained in Alfred Korzybski's "Science and Sanity." Some time ago, I wrote a letter to "Brass Tacks" in which I belabored the Doom Cult that seemed then prevalent among the authors who wrote for Astounding Science Fiction. Your cogent observation that

actual happenings in the world weren't doing anything to make the cult seem ridiculous brought me up sharply.

Once more I have cudgel in hand, preparing to take a swipe at some sacred cows. The fact that, as far as you are concerned, I might be wasting perspiration and energy fanning the air, does not deter me in the least. Although a fairly consistent one now, I have not always been a constant reader of ASF. I fell by the wayside during those years just prior to the use of Atomic Energy for Military Purposes being fairly convinced as were most laymen, that your authors were, for the most part, going off the deep end. Consequently, as a result of my foolhardy judgment, I missed a good deal of first-rate stuff—practically all of the earlier Thought Variant stories and those marked with the distinguishing "Super Nova" badge —stuff written by top-notch writers before they were taken into the Armed Forces or lured into the Oak Ridge research labs.

A friend of mine, out of kindness, recently loaned me several issues of the years 1942 and 1943 and while enjoying such classics as "the Weapon Makers," "Beyond This Horizon," "Waldo" et cetera, I had occasion to pay particular attention to the illustrations. I observed that some were very good, some fair and others frankly lousy. In reading your magazine, I have often noticed from time to time, letters appearing in "Brass Tacks" which criticized certain ASF illustrators but on rather vague and unprofessional terms. As one who once entertained budding ideas of becoming a commercial artist—even so far as to have majored in art in high school, following this up with a professional course via correspondence—I am, at least in a very small way, qualified to express at length some ideas over which I have mulled for some time. Ideas concerning

Art in The Field of Science Fiction

I realize that in taking pot shots at the boys behind the drawing boards and inkwells, I have also trained my sights directly on the typewriter brigade which stands directly in front of them. The illustrations that appear in ASF are based primarily upon the conceptions of the authors who write the stories. However, I am bearing in mind the full import of the quotation that heads this letter.

Even as Science Fiction itself has enlarged in scope and veiwpoint, particularly as found in ASF, and has freed itself from the impediment of currently trite and cliched ideas so often found in the run of the mill science fiction type of magazine, so too has the art of illustrating the science fiction story developed and enlarged itself.

Nowadays, the untrained, the ordinary type of illustrator could not readily cope with the peculiarly exacting requirements of an illustration

for ASF nor for that matter any other equivalent magazine—if there is one—in the field. I would venture to say that the more successful leaders in the field; the Rogers, the Cartiers, the Orbans and the Timmins, are either faithful devotees themselves of science fiction or else are extraordinarily well trained in scientific concepts since the field itself demands special talents of its illustrators; abilities that must keep up with the task of depicting ideas and scenes created by imaginations far in the van on unique and seldom trod pathways of thought.

And yet, skilled as these specialized artists are, they are still today hampered by the galling limitations inflicted upon them by the lag in current ideas of illustration and pictorial representation within the field itself. Commercial art today is still not as liberal in its willingness to free itself of the obvious and the ordinary as its elder brother; fine art. In this rarified realm we see impressionism, cubism, dadaism, primitivism follow one another in rapid succession all leaving permanently vital marks. New schools arise, blend or conflict, and are superimposed one upon the other; but not so in commercial art. Commercial art today is still just that: commercial. The technique of the air-brush represents the last frontier of originality.

Perhaps the fault may lie in the direction of the media of reproduction. Since there has been little or no newer techniques evolved in the science of off-set printing, lithography, line-cut and screen reproduction, so too has commercial art been stymied by the lack of revolutionary methods of conveying the art form. For instance, ASF is confined by necessity to interior reproduction by line-cut solely. Yet today it is practically impossible to reproduce a line-cut drawing in one, to say nothing of four, colors without undergoing a radical upheaval in the magazine's publishing economy. Thus the answer may lie in whoever finds a cheap method of multicolored single-process off-set reproduction.

So there exists the rather startling paradox of two channels of communication of ideas gradually drifting apart leaving a sadly unfilled gap between; the media of the written word is slowly leaving far behind the media of the art form. I admit that such artists as those I have mentioned who frequently adorn and embellish, to the usual satisfaction of most ASF readers, the pages of your compact and brilliant little magazine are striving to cope with the situation. But as good as they are, the problems of representing advanced techniques involving the physical sciences and the more acutely devised concepts of scientific philosophy to the satisfaction of the readers of these self-same ideas, presents an almost insuperable if not baffling obstacle.

The scientific concepts, entertained in such well developed works as E. E. Smith's "Lensman" series,

Williamson's "With Folded Hands . . ." and ". . . And Searching Mind," Russell's "Dreadful Sanctuary" and most of all, the wellnigh mind staggering exercises in Korzybski's General Semantics as contained in van Vogt's "World of Ā" series, are too often inadequately illustrated for the simple reason that no one seems to have really explored the possibilities inherent in the field of the art form when applied to the illustration of science fiction.

Who then shall blaze the trail and create the new science fiction art; the art of let us say, null-A where the older and A structurally conventional concepts of artistic representation will have to be discarded as unfitting in a newer and genius-exacting field? Who then shall evolve the ideographic symbolism as yet unearthed in the fertile field of semantic structure that will appropriately convey the meaning and significance of such concepts as van Vogt's energy-flow similarization effect, micro-wave synchronization, or magneto-electric physics in operation; stereochronology or Williamson's intricate but brilliant suggestion of the complex working of that superb science of the human mind: paraphysics?

As a specific example of the type of thing I mean; before 1945 there was no generally acceptable and immediately recognizable symbol to depict completely and unequivocally the character of the tremendous force that is meant by the all-embracing term of atomic energy. Yet after Hiroshima and the subsequent flood of accompanying publicity, clever minds were quick to settle on the symbol which you yourself have used many times since in your magazine, both in illustration and in decoration. Today everyone recognizes this symbol for what it is actually meant to convey. If such immediately recognizable symbols can be evolved for the comparatively simple concept of atomic energy, then why not as a logical consequence, others for a more complex and less obvious level of thought?

The problem of artistic concept I suppose revolves around familiarity of structure and pattern and generally acceptable semantic reactions. To logically evolve a symbol, it must represent an ∞-valued variable whose constant value can readily be assigned by the beholder or else it will be meaningless. If, as Korzybski says, the content of all knowledge is structural, then the symbol must compare structurally to that which in characteristics is patterned similarly to that which we seek to evolve. Of course this type of "logic" can be a trap as well as a boon. Our paths of thinking are as yet parabolic and not hyperbolic. We do not easily accept new and totally alien ideas without a painful process of indoctrination and otherwise lengthy and tedious routine of acclimatization. The gap between the known and the unknown is not easily bridged, for in order to create and indicate new paths for old feet

to tread, we must light the way with the torches of the familiar.

Let us then examine some of these familiar and often used conceptual tools in the art form that are used to light the way for timid and unhardened minds to the alien and outre in thought, as is found in the illustration of current science fiction. First, the concept of the

(1) Machine; its general attributes in science fiction art. The concept of the machine as a symbol of man's conquest of his environment, or as his inability to control his environment is and has been a prime motivating factor in most science fiction literature. Often the modus operandi involving man's manipulation or comprehension and conversely, misuse and incomprehension of machines. It is generally a vast thing, leaving much to the imagination, utilizing scientific laws and forces not generally in use. Four general observations can then be made about the Machine as represented by science fiction artists:

(a) It is Complex.

(b) It is composed of metal or other inorganic materials.

(c) In form it is rectilinear, rarely curvilinear, that is, a rigid geometry of form seems to prevail.

(d) It is usually colossal and cumbersome; generally unwieldly. There are exceptions, of course, but these exceptions prevail only at the specific description of the author, e.g., Clifford Simak's "Equalizer."

Here the observation can be made that in all justice to the artists they have their work prescribed for them by the imagination of the author. They cannot depart from the intrinsic material of the text they are to illustrate. But I scarcely can excuse them on this alone when in large numbers of instances, a careful examination of the description of the general background of stories, where machines are merely SUGGESTED and not actually described, leaves an enormous leeway.

Utilizing this leeway then, must we necessarily have the machine depicted as a complex incomprehensible jumble of metal, plastics, glass, or what have you? Scientists have long been looking for the perfect machine that is childishly simple in design. Let us say, a cylinder that generates from the edge of its outer surface a flow of energy that, passing to the interior surface, changes from positive to negative and release tremendous force in the process. Or a rod, a globe, a circular loop of plastic, et cetera. Science is on the road to simplification as witness the evolution of the airplane or the automobile.

Let us take the shape of the standard and conventional spaceship. Why in the form of a bullet when for the most part it will be navigating airless stretches of outer space? My wife has argued that in order to leave this planet, spaceships must

deal with atmospheric frictions and that aerodynamics have proved that the bullet shape is the ideal form. But is it? Why not the disk with the slightly convex center? Surely it complies with these frictional requirements. Again, concerning the composition of the machine. The limits prescribed by the authors again prevail. But why not a machine of paper, of wood, or even of flesh? Biology teaches us that the body, though not necessarily perfect, is an efficiently functioning machine. Note here the need for a simple all-embracing symbol to denote the complex reduction of potentials into kinetic energy flows such as the atomic symbol describes.

The prevalent tendency to depict the machine in rigid geometric patterns is a lag into old-fashioned and conservative ideas. In "Millennium I" a play by W. A. Higgins, I have seen the best examples of machine illustration outside of science fiction magazines I'd ever thought possible. They left a large area for speculation and whimsy. The adherence to geometrically rectilinear patterns, stems, I believe, from an inherent notion that such rectilinear construction lends an added air of massiveness and strength which a machine is supposed to impart. This, of course, is pure Aristotelian nonsense.

The depicting of the machine as a cumbersome and unwieldly object and not as a light fragile thing is also in the same groove and subject to similar criticism. The old Romans built their bridges of stone and their houses and temples of massive blocks as they were schooled in a more primitive architectural science than moderns. Plus the fact that they had no structural metals at the time. Could they but see the comparatively light and fairylike spans of the George Washington and Golden Gate Bridges, or even the thin slab of the RCA Building, they would scratch their heads in puzzlement and inquire: "What holds it up?"

Still, the illustrations of today are a far cry from the overdrawn and complicated conceptions of earlier science fiction publications. The ideas involved were based on then current theories of physics which have since given way to the more advanced ones when the Einstein Theory became popularized for the public benefit.

To move to a second category of attributes involved in the illustration of science fiction material, there is the question of the characters; both alien and human; their background illustration and design, such as dress architecture, et cetera. Here we have prime examples of the limitations in style imposed upon the artist by the conventional in conceptual art. Since many a science fiction story revolves around the conflict between either human beings and alien beings from beyond the normal environment, or else between sympathetic and nonsympathetic human and nonhuman characters, the old Aristotalian logic seems

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to have been particularly tedious and hard to get rid of here. Again the fault must be laid at the doorstep of the author since he alone is the father of the brain child the artist must illustrate. Yet the author need not take all the blame for the artists are still slaves to old ideas and traditions in lines of thought. This trend of thought runs into four general classifications, namely:

(1) The alien is a repulsively ugly creation to be depicted along reptilian, or if unsuitable, then entomological lines. This because of our innate revulsion of snakes and other supposedly disgusting forms of reptilian and insect life. The lower the form the greater the horror inspired. To us this represents the antithesis of the human form, therefore aliens are best represented by these forms.

(2) The alien, if represented along inorganic lines, is usually a frightful monstrosity of metallic, nonmetallic, amorphous, liquid, gaseous, or even purely energetic form such as light, electricity, et cetera.

(3) The farthest from earth the alien's origin, the more outlandish his conception. This is true even of the greats such as van Vogt—sic the idea of the "Rull," the "Ezwal" et cetera, and in E. E. Smith's concept of the Eddorians, the ultimate in this type of concept.

(4) The alien is—on the whole—an unsympathetic creation. That this is not necessarily so, I admit. Sic Smith's concept of the nonhuman Lensmen and the Arisians. This idea is gradually changing under the talented hands of our more imaginative authors. On the whole, it can be said that the alien concept is designed to inspire horror and by reciprocation, sympathy for the hero. This device has more than once worked in the place of an author's deliberately carefully delineating the character of his hero. The horror-sympathy equation obviates a lot of hard literary work.

On this I might add a few words as to the relative merits of ideas concerning extraterrestrial rational life. It is obviously your opinion that as bipedal humanoids, the highest form of life on this particular planet in this particular solar system, we are unique. I would hesitate to agree although you could parade enough mathematics and logic to prove your point. I feel and sincerely so that this is not necessarily the case. Many a well-sounding theory has been upset on lesser beliefs, but I cannot help thinking that the conditions which obtained for our evolution upon Earth can well be duplicated on many another planet in star systems undreamable distances from ours. To support this belief, authors like van Vogt have written contending that human life may well populate our farthest stars in the galaxy. Smith in his Lensmen series also tends to support this.

The constantly increasing range

of the imagination of science fiction authors have explored depths of unplumbed seas of ideas. The assumption, therefore, that infinite duplications of an android form of life is not too alien for these minds to conceive. There does not seem to be any really plausible reason to deny that man is not unique but rather the opposite can be assumed; that alien forms of life may be only exceptions to the rule. Here again we refute a general assumption concerning alien life forms. Alienness need not reside in physical structure alone. Alienity of ideas is more probable since ideas are more real than matter. Passing from the alien character in the story, one must now transfer to the human and here we find to an amazing degree the paucity of ideas afflicting the run of the mill artists.

The general time locale of the science fiction story is always a bit in the future. This, of course, naturally makes it harder for the artist to depict such ordinary things as clothing, architecture, vehicles for surface transportation, et cetera, except when specifically described. Any attempt to depict the man of the future must depend upon an assumption of trends that currently prevail. How far one can go wrong is amply shown by comparing some of the early art work in science fiction showing scenes of the present day!

The artist, then, is hard put to do active justice to the work he is illustrating. Clothing, our most fundamental cultural implement, has confounded many of the best science fiction artists when asked to speculate on the future. Rogers, in illustrating the last of the Lensman stories insists on drawing the hero wearing a uniform redolent of swash-buckling soldiers of fortune of the fiction of the twenties. Orban, in illustrating Lawrence O'Donnell's "Clash By Night" and "Fury" demonstrated a little ingenuity in the clothing of the Venusian colonists—plastic headgear and loose clothing designed for comfort. In contrast to this, Rogers has Gilbert Gosseyn on the October cover as a lurid trapeze artist.

Yet this same Rogers, in illustrating ". . . And Searching Mind" does a wonderful job on Claypool, having him wear sensible utilitarian clothing that must some day come into general use. The trend in clothing can no more be predicted than can the trend in ideas, since they are interwoven. Witness the so-called "New Look" which is a simple reversion to styles of thirty or forty years ago indicating that in the face of an atomic age, peoples' minds are frantically seeking to escape to the past. Clothing is the one thing that we cannot say for sure will conform to the scientific idea of functionalism. The human body needs only a certain amount of clothing as the ancient Greeks amply proved with stark simplicity. Yet human psychology has denied that the body is meant to be clothed for protectional reasons alone. Ideas of ornamenta-

tion, current ideas in art have inflicted themselves upon modes of dress. Since no one has as yet predicted with any great accuracy idea trends, any guesswork upon the dress of the future is just that.

Similarly in architecture. Idea trends have greatly influenced architectural forms. Religio-political upheavals, cultural revolutions, and sometimes scientific changes have made themselves felt in the building of structures. City zoning laws for adequate light and air greatly influenced the forms structures have taken in large cities with restricted area and even gave birth to the "skyscraper." This form is so radical that they have been erected on the plains of Texas where there is no earthly use for them since space is of an abundance there.

Even in the physical structure of men themselves, faced with the appalling prospects of an atomic war and the concurrent possibilities for mutations within the species, are the ideas still limited. In the face of the unknown we are still all too timid.

What I have written so far I hope has done much to re-affirm the need for artists of far-reaching imagination to do justice to the creative efforts of your best authors. What is needed, I repeat is a whole school of art, geared to the needs of a new trend of thought delving into unknown depths of challenging seas of ideas, new art symbols need to be devised; symbols evolving from the familiar and expressing advanced ideas adequately and simply. This is a challenge to present artists and to those who aspire to enter the peculiar field of art in Science Fiction Literature. It is also a challenge to a competent writer to fully discuss and formulate the problems and needs arising around this subject. I believe a very good article could be written concerning the matter and I for one would enjoy reading it.—John A. Savage, 332 Englewood Avenue, Englewood, New Jersey.

Our distribution down that way isn't very good, I guess, now the GI's are out!

Dear Sir:

I have been a strong supporter of science fiction for quite a number of years. However since being stationed in Malaya with the Royal Air Force I find it practically impossible to obtain any science fiction magazines whatsoever.

If you would be so kind as to ask your readers to send me any old or duplicate copies of science fiction books which they do not want, I would be greatly indebted to you for helping to brighten a somewhat cheerless existence far away from England—D. S. Gardner, 2373719 L.A.C., Post Office, Technical Wing, R. A. F., Maintenance Base F. E., Saletar, Singapore, Malaya.

BOOK REVIEWS

"Space Cadet," by Robert A. Heinlein. Charles Scribner's Sons, New York, 242 p. Ill. $2.50.

A generation ago, science fiction readers insisted on meticulous detail in their stories. We wanted to be told what space looks like and feels like, and what happens to your innards when you go weightless or take on a few extra G's of acceleration. It was old stuff even then—Jules Verne had set the style—but it was new to us. As the novelty palled, knowing writers left more and more to the imagination, until today's newcomer is apt to flounder in taken-for-granted conventions. However, there is no formula so old that a good writer cannot put life into it, and this Robert Heinlein has done with real success in his latest "juvenile," "Space Cadet."

"Space Cadet" is written for more mature readers than Heinlein's previous book, "Rocket Ship Galileo" —Scribners, 1947; $2.00. Indeed, it is more adult and better written than many science fiction "classics" now reprinted in book form. It describes, simply and directly, the grueling process by which young men from all parts of the solar system are forged into officers of the Interplanetary Patrol, and how they learn for themselves what the Patrol stands for in the world of 2075. So subtly has the scientific detail been interwoven with plot and action that the reader never realizes how painstakingly it has been worked out.

A rare few historical novelists like Conrad Richter are able to make their characters and story grow out of the background of the period in which they live. "Space Cadet" is a first-rate historical novel of the near future. Buy it for your nephew—but get an extra copy for yourself, or he'll never see it.

P. Schuyler Miller.

Willy Ley: "The Lungfish, The Dodo, and The Unicorn" (An Excursion into Romantic Zoology), N. Y.: Viking Press, 1948.

Like the lungfish of which the author writes, this book, since its original publication in 1941 as "The Lungfish and the Unicorn," has gone into suspended animation and then has unexpectedly come to life again. When the original publisher was liquidated by World War II, Viking took over distribution of the remaining unsold copies, including four hundred that had never been bound. When the bound copies were all sold they went to look for the unbound ones to bind them—but

these had disappeared, presumably having been "cleaned up" during a paper-drive.

Now, with peace and paper, the book has reappeared. Like its title, however, it has become considerably fatter than the original version: 361 pages compared to the original 305. There are several entirely new chapters, and most of the rest has been rewritten.

In case you don't know the original "Lungfish," it was one of the main books of Lore with a capital L, of the kind that every science-fiction reader and writer should own as a matter of course. For it dealt with the border-lines of zoölogy—with that fascinating region where science, speculation, and myth meet. The author told about mythical animals like the unicorn, the dragon, the basilisk, and the sea serpent, and with the possibility of real creatures on which these myths were based; with recently extinct animals like the aurochs, the great auk, the dodo, the giant sloth, and the sea cow; and with curious survivals of the past, "living fossils" and "missing links" like the horseshoe crab, the okapi, the platypus, and the lungfish. Like all Willy's books it combined fluent, easy writing with an astonishing range of information, many sources being medieval and early modern European works not available in English.

In the new version, for instance, we have two chapters in place of the original chapter on giants. One new chapter is exclusively about dragons, while the other, on giants proper, works in the recently found giant ape-men of southeastern Asia, Gigantanthropus and his relatives. Then there is a whole new chapter on "The Vegetable Animals"—the barnacle goose and the barometz or vegetable lamb; and also on that prince of liars, Jean de Bourgogne alias Sir John Mandeville, who in the Middle Ages did much to spread belief in such things.

Next comes another new chapter on the kraken or giant squid. This is an expansion of the piece on that subject that the writer once did for Astounding. The sea-serpent chapter has been brought up to date with an account of the meeting of the *Santa Clara* with a monster in 1947, and a mention of the Zeppelin theory of the Loch Ness monster—that the monster was part of a German airship that fell into the Loch during World War I. The author, despite some adverse criticism, sticks to his own theory of the sea serpent: that it is a large unknown marine mammal, something like a long-necked giant seal. The chapter "Rumors and Shadows" in the section Myth? has been fattened by an account of rumors of a leopardlike marsupial carnivore in Australia.

In the section called "Extinct!" we are brought up to date on the precarious state of the European bison. Then there is a new chapter, "The Almost Unknown Wild Horse," on the extinct European forest horse, of which the last

specimen died in Russia in 1879. This animal, the ancestor of the domestic horse, was quite distinct from the Przevalski—pronounced pshev-*al*-ske—horse that still runs wild in Central Asia. There is a chance that the European forest horse could be re-created by selective breeding of domestic horses, as the Heck brothers re-created the extinct aurochs, described in Willy's chapter "Urus, Wisent, and Bison."

The last section of the book, "Witness of the Past" has a new chapter on the koala. The big last chapter of the former edition, called "The Story of Gondwanaland"—which did not hang together well—has been broken down into three new chapters: "New Zealand Interlude," "The Origin of the Mammal," and "African Rhapsody."

Altogether the author has done a sound job of revision of what was originally a most desirable book. Aside from a few trifling differences of opinion, my only criticism is that there isn't more of it. Perhaps in another decade Willy will revise the book again, adding a chapter on the *martichora* to the first section, one on the woolly mammoth to the second, and one on the lamp-shells to the third. But in the meanwhile, for those of you who have a copy of the original already, the new version is well worth getting. And for those who do not, it is a must.

L. Sprague de Camp.

THE ANALYTICAL LABORATORY

The report below concerns the February issue; I want to thank the many readers who sent in the little questionnaire from the March issue—readers who are, I realize, very interested in knowing the results. Those results will be published; they can't be published as yet, because at this moment only a week's accumulation is available. The results are going to be highly gratifying, however, if that week's summary means anything. Be patient, good sirs and mesdames, we'll give the answers when we've got 'em!

But to the February issue:

Place	Story	Author	Points
1.	Manna	Peter Phillips	2.61
2.	Seetee Shock (Pt. 1)	Will Stewart	2.87
3.	Prisoner In The Skull	Lewis Padgett	3.16
4.	Present From Joe	Eric Frank Russell	3.61
5.	Next Friday Morning	D. W. Meredith	3.95

The point scores look a little higher this month because we had six fiction pieces this time, giving vote points from 1 to 6. (And every story got some ones—some sixes!)

THE EDITOR.

REACTOR RESEARCH

(*Continued from page 6*)

placed by an equal, or possibly greater amount of Pu-239, at the expense of the otherwise useless U-238. The Pu-239 produced could exceed the U-235 consumed, because the fission releases two-*plus* neutrons; one to make the reaction self-sustaining, one to make an atom of Pu-239 for every U-235 consumed, and that slight plus available to make additional, extra Pu-239. Thus, theoretically, starting with two hundred thirty-five pounds of U-235, we might wind up with two hundred seventy pounds of Pu-239, at the expense of the U-238 present. Or, equally, perhaps two hundred sixty pounds of U-233 at the expense of Thorium-232 added for the purpose.

A reactor which can accomplish this highly desirable end is called a "breeder" reactor. It's something like feeding hens a mash consisting of eggs and corn to get more eggs; we hope the eggs put in the diet will cause the hen to convert the corn into a larger number of eggs. So far—as best as can be judged from published data—no one has succeeded in getting a reactor of quite that degree of neutron efficiency.

All reactors so far—with two types of exceptions—have been of the highly-moderated, low-energy-neutron type. That's the only type that will work with natural uranium. The two classes of exceptions have been the atomic bombs, which were high-neutron-energy reactors and used pure U-235 or Pu-239, and the high-energy reactor at Los Alamos which also uses pure Pu-239. This latter is purely experimental.

The present proposals involve two types of novel reactors. First will be a high-neutron-energy unit,. running on highly enriched uranium—natural uranium with a heavy addition of U-235 or Pu-239—designed to act as a power-reactor as well as a breeder reactor. Remember that the U-235 fission yields neutrons *and* energy. If things go right, we can not only increase our available nuclear fuel supply, but get the full energy output of the U-235 while doing it.

The second type of reactor will also be a breeder-power unit, but will operate at intermediate neutron-energies. The first type mentioned will be unmoderated—the full energy of the neutrons will be allowed to remain. In this second type, some moderator will be included; the neutrons will be slowed down, but not as much as they have been in past reactors. This reactor also will require enriched uranium.

Now both of these units will be primarily experimental; power produced will be used solely for measuring purposes. The main point is to measure the nuclear constants involved, and find out what is the best, most practical type of breeder reactor.

But the Atomic Energy Commission has another Grade A problem. Still another reactor is being built for a third related problem. We've discussed the U-235, U-238, thorium, and plutonium that go into reactors—but other things have to go in too. Concrete walls, and electronic instruments, graphite blocks and heavy water, electric wires and insulating materials. All of these auxiliaries are nuisances, but highly necessary impediments. It's all very well to know all about the atomic fuel atoms, but useless if we know nothing about

the engineering materials that must be used to handle them. And, to date, we know practically nothing.

So far, we're in somewhat the position of the early designers of bridges. We guessed that this or that material would work, but having no way of testing it, had to go ahead on hunch. The old bridge-builders figured that a 12 x 12 oak stringer would carry the load, and that if it broke they'd build the next bridge heavier. The modern designer takes his material to a materials testing lab, puts it in one of the giant testing machines, and crushes, pulls, twists and bends it till he knows precisely what it will stand.

The Atomic Energy Commission is building a materials testing machine—a nuclear reactor for the sole purpose of measuring the properties of materials in intense nuclear bombardment areas. This reactor will not produce power, will not be expected to produce plutonium, or anything else save only data. This reactor will be operated with local neutron and other atomic activity at extremely high intensity—much higher intensity than any of the reactors in use now, though the total power level will not match the giant reactors at Hanford.

Entirely new problems of design have been encountered, of course—these new units will be almost as great a departure from previous work as was the Los Alamos bomb design from the pre-existing pile designs of Oak Ridge and Chicago. The reactor design research is now concentrated primarily under the Argonne National Laboratories of the Atomic Energy Commission in the Chicago area. The reactors themselves will probably be

built somewhere in the Western United States, however.

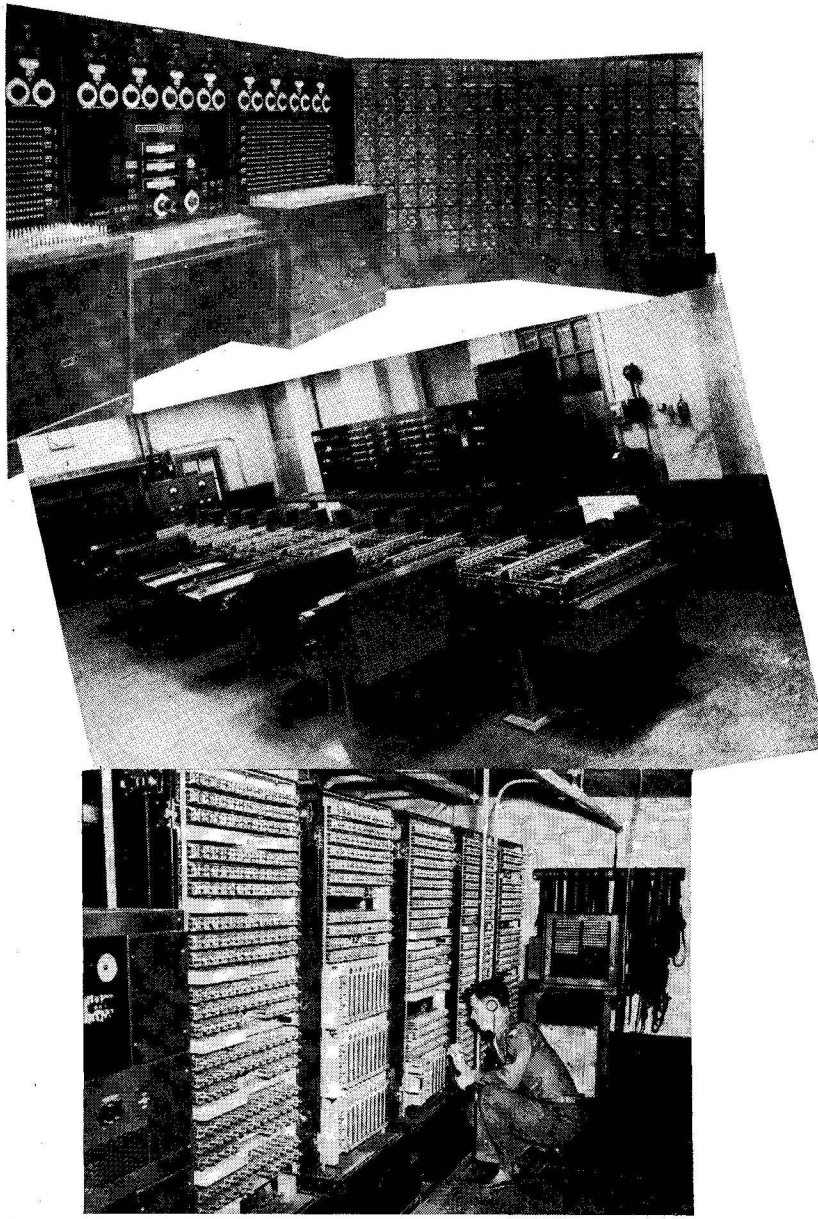
It is probably going to be extremely difficult to make a truly successful high-neutron-energy breeder-reactor; there are engineering as well as nuclear problems in this business. To have a high-energy neutron system, the neutrons must go directly from fissioning atom to target atom, with no energy-sapping collisions with non-reactive materials. There must be nothing but uranium—U-235 or U-238—present, in other words. To the pure nuclear physics requirements, however, the engineering requirements must be added. The neutrons are important, but the energy released, the heat generated, must be controlled. If not carried away, it will fuse the uranium. But no heat-transfer agent can be added effectively, because of the no-inert-material requirement. Without using a heat-transfer agent to carry heat away, the cooling must be by radiation, which is not very massive at temperatures below two or three thousand degrees. But if the reactor is run at the low power level this permits, even if it is an efficient breeder-reactor, it won't be very useful; it would take too long to process one ton of U-238, since a given quantity of U-238 transmuted requires the release of a given—and enormous—number of heat-energy units.

The intermediate-energy-neutron reactor looks like a better bet. The intermediate energy level means that *some* moderating material may be present. In the low-energy reactor, extremely efficient slowing-down materials like graphite or hydrogen are used; by using in the intermediate-energy reactor extremely *in*efficient moderators such as lead, bismuth or the like, reasonable quantities of heat-transfer agent can be put in the pile without too greatly reducing the neutron energies. This would permit fairly efficient heat-transfer at satisfactorily high neutron energy levels, and molten lead or bismuth would permit high-temperature heat-transfer operation which would be effective for generating steam and thence power.

In any case, extremely important research work—research too expensive for any private company to undertake, too large-scale for any university—is being started. The AEC appears to be launching a bold, vigorous, and well-planned attack on the whole problem, across the entire spectrum where knowledge must be gained. The AEC itself is setting up the materials-testing reactor, and the high and intermediate energy reactors. With Westinghouse Electric Company, the AEC is setting up research on ship-propulsion nuclear reactor systems. A land-based reactor is being built to study this problem. For some time now, the Fairchild Aircraft people have been doing research on nuclear propulsion for aircraft. General Electric Company, at their Knolls Laboratory just outside Schenectady, New York, and as managers of the Hanford Plant, is in full co-operation with the AEC in reactor research.

The problems are real and tough; the necessary research facilities are the first requirement, and those are in process. It has taken years of study and evaluation of data to be in a position to say exactly what type of data we do need, and what type of reactor will give us the missing figures. Now those reactors are under way.

The Editor.



Three types of computers. Top: General Electric's A.C. Network analyzer. Middle: The differential analyzer—of the analogue computer group—at General Electric. Bottom: The Bell Laboratories relay-operated digital computer.

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