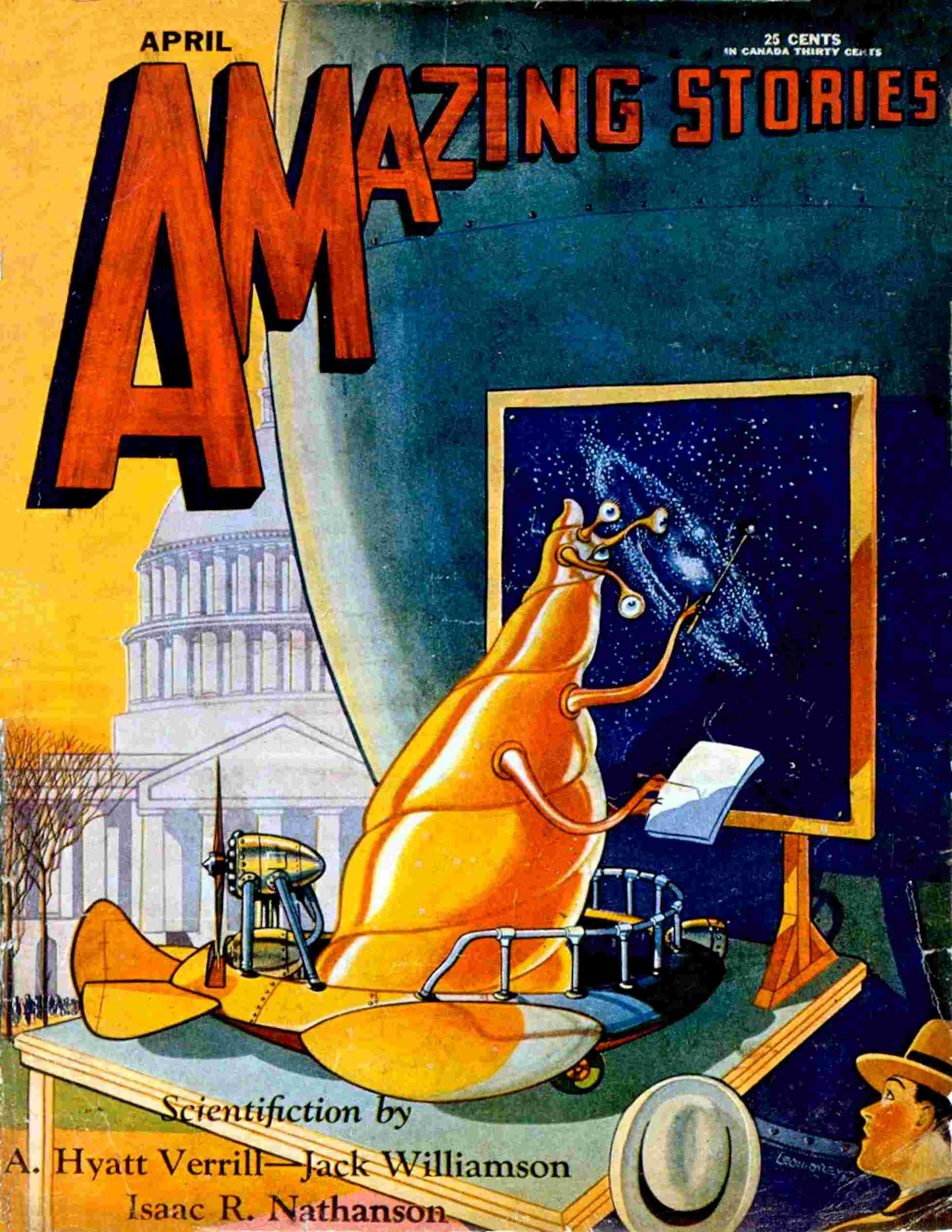


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Scientifiction by

A. Hyatt Verrill—Jack Williamson

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*** START OF THE PROJECT GUTENBERG EBOOK THE METAL
HORDE ***

The Metal Horde

By John W. Campbell, Jr.

Author of "When the Atoms Failed."

Illustrated by DE PAUW

What with calculating machines and robots and now perhaps even mechanical airplane pilots, there seems no limit to the possibilities in the realm of working machinery. We have seismographs that can locate the place of distant earthquakes, and machines that can solve, in a comparatively short period, problems in the higher calculus that would otherwise take brilliant mathematicians an endless time to do. It seems to us quite logical that machines might some day, perhaps

*in the distant future, be developed to
solve for our scientists now
apparently insoluble problems. Or
they might even be made to state
their own problems and work them
out—in other words, it might some
day be possible to have a machine
with almost a working brain.
According to our author, this will be
possible and his final explanation of
his idea is exceedingly clever and
novel. There is no question Mr.
Campbell knows his science and he
has by this time proved his ability to
weave a great deal of sound science
into an absorbing scientific fiction
story of exceeding plausibility.*

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It would seem lack of generalship that permitted them to be discovered so soon, for had we not picked up those signals from the ether we should not have received that warning that meant so much to us, and it might well have been that this system would have acquired a new population. For it would have needed but little to shift the balance the other way! Once I watched Steven Waterson save the civilization of the Earth, but now I saw him in a greater rôle, for it was he who made possible the defeat of the Sirians. But even had his brilliant mind succeeded in working out the problem of the deactivating field without the precious hours gained by that warning, many millions more would have died before they could have escaped from Mars.

I was in his laboratory at the time he received the messages from the System government telling the import of those strange tone-signals out there in space. I seem fated to be with that man every time some great event breaks on the System. I was with him when Dr. Downey announced his discovery of the secret of old age—or, better, its prevention. Waterson was forty-two now, in years, but in body he was still twenty-eight for it was late in 1947 that he had taken Dr. Downey's treatment.

Those strange tone-signals had been heard faintly for days, but it was not until July 8th, 1961, that they were located in space, and then man began to realize something of the message they might bear.

Waterson asked me to accompany him to the System Capital on Venus, and I was present at that first Cabinet meeting, and at each succeeding meeting. Again I was close to the facts—and again Waterson has asked me to write a chronicle of that terrible War.

It was not till the signals had definitely been located as originating far out in space that man began to take more than a mildly curious interest in them. They were coming from the Metal Horde that was even then sweeping across space at a thousand miles a second to the planets ahead.

Their goal of ages was in sight. Sixteen hundred years of ceaseless rushing flight had at last brought them near.

When our ancestors were beginning to grumble under their Roman lords, in the time of Horlak San, when his mighty armies were sweeping their way

across Mars under the newly developed heat rays, spreading death and civilization at one time, that menace started on its expedition.

When the Normans invaded England, when the mighty empire that the San dynasty had maintained over all Mars was crumbling, that journey was half done.

When Columbus first set foot on the shores of America, when Koral Nas formed the great union of the federated nations of Mars, that trip was three-quarters done.

But it was seven-eighths completed when Mars developed the first crude atomic engines, and when Priestly of England discovered oxygen. And during the two centuries of flight that remained before they reached their goal, there developed on those tiny planets the instruments that were to throw that mighty force down to defeat.

But I am to tell you of that war as I saw it; we have all seen it—all too closely! It was really but a little more than a month that that Menace of Metal hung over us there on Mars, but to us it seemed years, except to the frantically working scientists, striving desperately to discover some weapon to defeat them. David Gale.

A tiny glistening mote in space it was, as it sped toward the shining planet before it—the rapid flight of the car aided by the gravity of Venus. The call had been urgent, and the Earth had been in superior conjunction, that meant a full twenty-hour trip, even at 1000 miles a second, but now they were approaching the planet and the pilot was losing speed as rapidly as possible. There was a limit to what he could stand, though, and it took him many thousands of miles to bring the machine down to a speed compatible with atmospheric conditions of the planet.

The air of the planet seemed thick with traffic, mighty half-million ton lift freighters and passenger ships setting out toward Earth, smaller private machines, but none were slower nor faster than the others, for all were limited only by the acceleration they could stand. There was only one speed limit, that of economical, safe operation, for with all space to move in, there

was no need of speed laws. Yet it seemed impossible to make any more than two thousand miles an hour through this slow moving air traffic—then there shone a little emblem on the bow of the little iridescent metal ship, and a huge freighter swerved respectfully aside. As by magic a lane opened through the thick traffic as the sign of the System President shone out.

The little ship darted along the ground a short way, then rose vertically, only to settle lightly on the roof of the great System Capitol. Two men came out and walked quickly to the elevator entrance, where three guards, armed with disintegration ray projectors, greeted them with a stiffly military salute. The larger of the men responded with a smile, and a brief salutation in the common language of the System, for these great men were Martians, each well over eight feet tall. They entered the lift, and quickly sank down one hundred and fifty stories to the Governmental Offices. They proceeded directly to the great Cabinet chamber, down through the long halls, lined on each side by huge murals depicting scenes in the history of the three planets. Then they came to the cabinet room and entered.

Thirty-nine men were seated there now, but as the two entered, they rose, and waited for the President to be seated. The forty greatest living men were in that room that day and all worked together, for they were scientists who had learned the value of cooperation. There was no rivalry, for each was the greatest in his own field and had no aspirations toward any other branch of science. And none but conceded the power of the Presidency gladly to the greatest of them, Steven Waterson of Earth.

"Gentlemen of the Cabinet, I am beginning to believe it is time we had something added to the Constitution forbidding Members of the Cabinet to rise on the entry of the President." Waterson deeply appreciated that compliment, as they all knew, but he could not feel at home in an atmosphere of diffidence. He was a scientist, a planner, not a diplomat. "I am sorry I was forced to make you gentlemen wait for me, but as you see," he continued, pointing to the great map of the System on the ceiling of the Cabinet chamber, where the slow motion of the planets in their orbits was being accurately traced, "Earth is in superior conjunction at present, and I could not make better time.

"I see from this memorandum that has been prepared for me that Mansol Korac, Martian Astro-physicist, is to be our first speaker. I take it you have

had no official discussion as yet?"

He was correct in this assumption for the men had convened shortly before at his radio announcement that he would land within an hour.

Some years before there had been some agitation to have the Cabinet meetings carried on by Radio-vision plates, but the low speed of light had made the speeches a terrible failure, as they would frequently have to wait ten or even fifteen minutes while the radio messages were reaching them. Over short distances that method was practicable, but between planets light is too slow, it cannot be used.

"Some time ago our radio engineers developed a new instrument for detecting exceptionally short waves. They really came under the category of the longer heat radiations, but were detected electrically. While experimenting with this device they have been consistently picking up signals apparently originating in free space. At first these signals were exceedingly weak, but their intensity has grown uniformly and rapidly, and from the results some amazing conclusions have been drawn.

"They are originating at some source or sources out in space in the direction of the sun Sirius. I was asked to help the radiation engineers under Horus Mal in the calculation of the Astro-physical aspect of the problem. I believe that there are some man-made vehicles out there in space sending those signals. No man of the System has ever had reason to venture beyond the orbit of Neptune for any great distance; there would be no reason for it, as none of the outer planets are habitable. The rate of increase of the signal strength, coupled with observations made from Earth, Mars and Venus, have made it evident that they are at present about one and a quarter billion miles away, but approaching us at the rate of 1000 miles a second. This means that in approximately two weeks they will reach our planets.

"As to their point of origin we can only make guesses really. They are coming toward us with Sirius—and thousands of other stars—at their back. Of all, Sirius is the nearest, being approximately nine light years away. This means that they must have spent at least 1600 years on that trip across space. Dr. James Downey of Earth has recently shown us how to lengthen

life almost indefinitely, so the problem of old age need not be considered. A supply of air and water would, of course, be no great problem with the Waterson apparatus for electrolyzing CO back to carbon and oxygen, using atomic energy fuel. Water, of course, is merely transmuted and recombined and thus automatically purified for use. A sufficient reserve of very dense materials could easily be carried that would make up for any losses by transmutation to the necessary gases. As yet we have not been able to make foods from energy, carbon, and oxygen and hydrogen, but I believe you, Dr. Lange, have made very considerable progress along that line, have you not?"

"I intended announcing at this meeting," said Dr. Lange, "the development of a commercial method of manufacturing any one of the sugars and several proteins directly from rock or water, by a transmutation and building-up process. The method has been developed."

"Then," continued the Martian, "there would be no need of carrying any great amount of food. That problem is settled."

"As there would be no resistance encountered in space, once the machine had been accelerated to its definite speed of 1000 miles per second, on leaving Sirius it would be able to make the trip across space with no expenditure of energy, until it reached its goal and slowed down to the speed of a planet. Hence no great amount of matter-fuel would be needed to drive the machine."

"But the problem of heating seems to me to be insoluble. Interplanetary space we have the radiations of the sun to depend upon, and they are decidedly sufficient, usually superfluously so. But in the infinite depths of interstellar space, there is only darkness and a perfect reservoir for radiations. There would be continuous cooling by radiation, and no sun to warm the ship. I could understand how the ship might carry enough matter to warm it for one hundred years, but in sixteen hundred years so much energy must be radiated that the entire mass would not suffice. Nothing short of an entire planet would be sufficient. Polished walls would reduce the radiation, but still it would be too high. I can not understand it—unless these men can endure a temperature of but twenty or thirty degrees above absolute zero—then they could make it quite readily—but two hundred and forty degrees below zero Centigrade means that air—nearly everything

would be solid, except a few rare gases. No it seems impossible—yet we have the evidence! I can not understand how they have made this terrible migration, but I know that there are many different units. I believe two thousand or more was the number you mentioned Horus Mal?"

"There seem to be a very considerable number of separate signals that we can distinguish. I consider the two thousand a very conservative estimate," replied Horus Mal, the Martian radiation engineer.

"Then," continued Mansol Korac, "we must decide on some plan of meeting them."

The Martian sat down and for some time there was silence in the great hall. At last President Waterson rose slowly to his feet. His face showed his concern. In times of emergency he always felt that these men here were responsible for the welfare of the twenty billions of human beings they controlled. And he was their leader, and therefore the responsibility was his.

"Mansol Korac, could you point out to us the approximate location of the approaching ships?" asked Waterson and handed him a small hand light and pointed to the great map of the system above them.

"I cannot be very exact, Mr. President; I do not know their location very definitely, but I should say about here, proceeding thus." The dazzling beam of white light stabbed up to the ceiling high above, and a sharp circle of light a foot across appeared, just within the orbit of Uranus, but well beyond Saturn. Then it slowly moved inward toward tiny glowing Mars. They were within the Solar System, but had not yet reached the Inner Ring of planets. Doubtless they who could make a trip across the great Void had the energy of matter at their disposal, and probably the disintegration ray. They would have no difficulty with the planetoids, they could merely beam them out of existence if they came too near.

The light snapped out, and each member of the cabinet turned toward Waterson again.

"Gentlemen, we see that they are within the Solar System already and appear to be heading directly for the Inner Ring, and Mars in particular. I do not know whether they come in peace or as invaders, but I think I can reasonably say that they are probably invaders. We all agree that they have made a trip of some 1600 years' duration. We all recognize the difficulty of

such a trip. There are over two thousand ships in their fleet. I would not send so large a fleet to investigate the Outer Ring, but to send that great number of ships on a mere exploration trip of 1600 years—I do not think it is consistent. Then, too, we must allow them a life span of over three thousand years if we are going to admit that this fleet is for exploration, for it would be three thousand two hundred years before they could bring back news of their trip. In the meantime they might well have been wiped out by some stellar catastrophe, or they might have developed means of seeing us directly in nine years, the time light takes for the trip. Much as we would prefer peace, I fear we must prepare for war. But we can always go out to meet them peacefully, in a great battle fleet. That might convince them that it is better to deal peaceably with us and it would at least be a protection. I suggest that we have a discussion on this, and take a vote."

But there was no discussion, and the vote was unanimous, for the President's suggestion was the logical thing. They had to be prepared for either peace or war.

Then came the discussion of weapons. There was pitifully little to discuss. The interplanetary patrol fleet was a mere police force, designed to destroy meteors, turn comets or asteroids. There was no real naval fleet. But mechanical devices had reached a great peak of perfection and the little space ships were so cheap, so easily operated, and so eminently safe, that nearly every family had several, and new ones were always in demand. There were mighty factories to meet this demand. Twenty billion people can absorb a tremendous number of machines. That was the greatest protection we had, and it was that quantity production, developed by the American, Ford, that made Waterson's campaign possible. But we were to learn much of quantity production methods before that war was over!

Orders were issued that evening to all the great plants over all three planets to begin work on a great quantity of ten-man-high speed ships. They were to be arranged with mountings for machine guns firing explosive bullets loaded with material explosive, each one equal to 100 tons of the old fashioned Dynamite, with special mountings for Dis ray machines. The disintegration ray machinery was to be built by the companies employed

ordinarily in making private power plants, hand lights, and the jumping belts. These belts had small projectors that threw a directional beam of force that tended to deform the curvature of space, at that point, and the result was a force that pulled the projector forward, for the space before it acted like a spring. If a magnet be held near a steel watch spring, the spring will bend, but it will try to straighten out and pull the magnet forward. If the magnet could pass through the spring it would progress, as the space curver apparatus was pulled through space. This was the principle of every ship now built, from these tiny two-kilogram (nearly five pounds) machines capable of lifting a man into the air, to the titanic new passenger-freight liners carrying as high as three quarters of a million tons.

The principle of the disintegration ray was not greatly different, and so the machines designed for turning these out in quantities were used to make the Dis ray apparatus with no great changes.

The heat ray projectors were made in quantities for every purpose, they were used for cooking, for welding metals, for warming the home, for melting down cliffs to make way for a building or a tunnel for water, for heating the mighty space ships, for anything to which heat might be applied to advantage. These would make very effective weapons but for the fact that heat rays could be reflected. They would bounce off the car of the enemy without doing any damage if it were polished, as no doubt it would be.

Great liners of space were requisitioned and fitted with Dis rays, and with mighty attractor beam apparatus that would grip and hold anything short of another liner. Each of the ten-man-cruisers had a smaller attractor beam by which they could grip an adversary and hold to his tail with the tenacious grip of a bulldog and yet not weary the pilot with violent movement. These ships were exceedingly powerful, and their speed was limited only by the accelerations the passengers could stand.

But all the scientists of the System were working desperately to design some new weapon, some new machine that was a little faster, a little more powerful; although with resistance in space and with the tremendous energies of matter at their disposal, there was little lack of power as far as the speed of the ships were concerned. Ten thousand times more powerful than the titanic energies of atoms, this energy had defeated the Martians that memorable day in May, 1947, and it was a full ten billion times more

powerful than the energies of coal, of oil, of the fuels man had known before that day. But they needed a machine that could project the Dis ray farther. Twenty-five miles was the limit, beyond that the tremendous electrical field that was used to direct it must be built up to so high a voltage that there was no practical way of insulating it. They must be satisfied with the twenty-five mile range—but the scientists were working at increasing the range.

They had two weeks before the Sirians would reach Mars, and in those two weeks much was done. There was a very carefully laid out system in all notices; the absolute truth was laid before the public, but there was also laid before them the evidences of Man's power. There were no panics. This was no weird thing to them, the landing of a fleet from another world; it was as commonplace to them as the landing of a fleet from the other side of the ocean had been a generation ago. The element of the unfamiliar was gone, and with it had gone the element that produces panic, that reduces the efficiency of a nation or of a System.

New production machines had to be built, new designs worked out, new dies cut, but it was done with the quickness that a generation of mass production had made possible, it was not new to them, this change of design overnight.

It required most of those two precious weeks to get the great machines working once more at their tasks, but at last a steady stream of ten-man cruisers was being poured out, 5000 an hour, night and day, from the factories of three planets. But there was only one day to work before the Invaders would reach Mars, and the fleet was gathered, 120,000 ten-man ships, manned by the volunteers of three worlds.

But in the meantime Waterson had had built for himself a ten-man ship with triple strength of walls, and triple power plant installation, and an extra energy generator. He was experimenting with it, no one knew on what.

At last the invaders were seen. Far out in their course the scouts had met them. Those scouts were destroyed, without provocation; they did not even have time to finish their reports, but we learned enough.

Mars was a deserted planet now. All its population had moved to the other worlds. Most of them moved to Earth, on the other side of the sun. Only the

workers in the great factories remained. They were not compelled to. They were told of the danger of their position, but those factories could contribute 1500 ships an hour, and they were manned. The fleet had gathered on Mars, awaiting the news of the Sirians, when the report of the scouts was flashed across the ether.

They told of a great horde of metal ships, shining, iridescent, ranging in size from tiny darting machines, ten feet long by one and three-quarters in diameter, mere torpedoes, to great transport ships. And there was a single spherical ship. A great sphere that floated in the center of a bodyguard of the thousands of its followers. There were literally hundreds of thousands of the little torpedo-ships, a few dozen of the cargo ships, and a few ships that seemed more like scouts of some sort. But it was apparent that the little torpedo-ships were the real fighters—tiny ships that spun and turned and darted like an electron in ionized gas. It seemed impossible that a man could stand those sudden turns at several miles a second, but they watched them, and went into nothingness as the Dis ray reached out from those tiny ships and caressed their ships.

They, too, had Dis rays—it would be a terrible battle, for man had that same force, a force so deadly they had feared to use it in industry. But man had the advantage of numbers.

The men on the fleet who saw those television plates glowing with the story of what was taking place out there in space decided that those torpedo-ships must be guided by radio. If they were it would be a simple matter to wreck that system by using a powerful interference that would drown out the directing wave and make its ships unmanageable.

The System Capital was temporarily moved to the Waterson Laboratories on Earth. There the forty men had gathered around great television plates and were watching the battle of the scouts. They were not to go to that battle front. The System needed them.

It was midnight on the part of Mars where the Sirians first struck. The fleet of the Solar System was massed there to meet them. They seemed headed for the mighty gleaming city of Metal, below. Dornalus, the second city of

old Mars; was there, and they seemed bent on reaching it. As the Sirians drew near they threw forward a great shield of the torpedo-ships; then the great generators on the Solarian fleet forced tremendous etheric currents into space, and waited to see the motions of the tiny ships become erratic, but they darted about as steadily, as easily as ever. These Sirians must be small men! And they must be from a massive world, a world that had accustomed them to great accelerations.

Below them the city was deserted except for vision projector machines that hummed steadily, automatically, from a thousand points. They were broadcasting the message to the worlds and to the commanding officers on the other side of Mars. These men had direct control of the battle. They could not control it from Earth, for radio waves travel too slowly. Twenty minutes each way the waves took and in forty minutes the battle was more than over. It lasted only fifteen minutes—minutes of terrific carnage!

As the two great fleets came into contact, the Solarians drove into the mass of tiny ships, their Dis rays flashing in every direction. They had one advantage in that they sprayed nine streams of death from each of their craft; but the torpedo-ships were so unbelievably fast that it was nearly impossible to hit them. And they seemed to have no compunction about raying one of their own ships if a more than equal amount of damage was inflicted on their enemies. Logical, no doubt, but how inhuman.

The sky above the city became a blazing hell of Dis rays, heat rays, and exploding shells. The explosives were not safe, for they threw great flying fragments that could pierce the wall of a ship and send it down. They damaged friend and foe alike.

The Solarian fleet had a solid projectile of a single giant crystal of copper that was immune to the Dis ray. It could penetrate the walls of a ship and bring it down. But the explosive bombs were more often than not exploded or merely disintegrated before they reached their goal. A crystal of any sort was immune to the Dis ray, but it was not a protection against it. There was no known way of deflecting the Dis ray except by that special electrical field that directed it, and that could not be made to surround a ship. The copper crystals were used mainly to destroy the Dis ray projectors of the enemy. They were fired at the faint glow, and with luck they would hit the machine and instantly wreck the projector. More than one machine

disappeared as its own Dis ray projector, wrecked by the fifteen-inch copper crystal, suddenly spread in all directions.

The sphere and its escort of transports hung back, surrounded by a great number of the torpedo-ships. They did not join in the fight.

And at last the Solarian fleet was recalled. It was not right that they should make such heavy sacrifices. The city must fall, and it would be easy to crush the Sirians with a larger fleet. At the rate of 5000 Solarian ships an hour, they might well do so in three days. So the Solarians left, and behind on the ground there were a few ships; a great number had been rayed into nothingness. The Sirians had won this first victory, but the Solarians could soon make up for this loss. They had twenty billions to back them up, and they had the resources of three planets. It seemed as though the invaders could not last long, but we had yet to learn the true meaning of mass production.

No man could hang around the encampment of that alien race. But above them television broadcasts were suspended, and some were installed in the buildings of the city. But these were of no avail, for the Sirians seemed obsessed with the idea of making Mars a true sphere. They proceeded to level the great city with Dis rays. No news projector could remain there, of course, and several news projector men lost their lives. It was foolhardy to stay in that city; they had been forbidden, but nothing will keep a newsman out of a chance for a scoop. The projectors which hung above continued to show a weird scene.

The great sphere and its attendant transports sank gently to the ground and formed a great wheel, with the sphere as the hub and the transports as radiating spokes and the rim. High above them the darting torpedo-ships were wheeling in constant circles. It seems a miracle that not all of those news projectors were destroyed, but some did last till the early rays of the sun set them off as shining targets for the flashing Dis rays. It was a weird scene they showed!

The great sphere and its attendant transports sank gently to the ground and formed a vast wheel, with the sphere as the hub and the transports as radiating spokes and the rim.

Now from the sides of the great transports came, not men, but great machines, machines that lumbered along on caterpillar treads to set themselves down beside their parent ship, one from each ship, and proceeded to dig themselves in, about three feet deep. Then all seemed quiet, except for a steady hum from the great machines, fifty-eight in all there were, great machines—fully two-hundred feet on a side. They worked there quietly now, and the men within them must have been totally covered, for they could not be seen. Apparently the Sirians dared not come out into the Martian atmosphere. And now something was happening that startled all the billions of watchers on the three planets. In the top of the great machines was a small trapdoor. Through this, there came a torpedo-ship that floated up a few feet, then darted off to join the wheeling machines above. Then eleven seconds later another came forth—another—each machine there was sending them out now. One by one those machines released a torpedo-boat—one every eleven seconds, with the regularity of a clock.

At first men could not grasp the significance of this—but soon it became obvious. These wonderful machines were complete factories in themselves, portable, mass production factories for producing those torpedo-ships, and one each eleven seconds came from the end of the production line, complete. The noises there were no longer a gentle hum. There was a whirl and rattle of machines. It was not loud, though considering the mighty works that must have been going on inside. But steadily now, that darting fleet of torpedo-ships was increasing the power for all this work was obvious to these men who used similar processes in their work.

From the soil below them the machines dug masses of matter, and carrying it up into the machine transmuted its elements, into the elements necessary to their machines, then molded them, and automatically assembled them. It would require very little supervision, but that production-rate was staggering! One each eleven seconds meant 325 completed machines an hour.

There were no signs of any men entering these ships, or the machines, so it seemed there must be some means of distant control that man knew nothing of, for it was improbable that all those men could have been in the parent machine from the beginning. No wonder the Sirians could lose these machines so freely. The ability to make them automatically from anything meant they cost practically nothing and could be produced in limitless quantity. The notion that Man was to be an easy victor was fast disappearing. These machines were coming to form an ever-growing cloud of wheeling ships. Still, man had destroyed fully half their fleet in that desperate struggle; they must spend some time in making up those losses. But Man had lost nearly a third of his great fleet. Four hundred thousand brave men had been lost. It was not even a victory, and it had cost Man far more than it had cost the Sirians. They had learned something from them, though. Perhaps radio control would enable man to do an equal amount of damage. Orders were put through to make an experimental fleet of thirty thousand radio-controlled machines.

In the meantime a new thing was attracting the attention of the people on the planets. A new set of machines was issuing from the transports. These were smaller than that first set—low and squat—but they seemed far more flexible in their movement. They went off in orderly line to a point a few miles distant from the main encampment and there formed themselves into two groups. One group remained still, but began to glow faintly, and a hum came to the televisions above. Then there began to flow from a spout on the side of each a steady stream of molten metal. This was poured into a somewhat similar arrangement on the other group, then these moved quickly away, and with their strange handlike appendages began to work quickly at a great rounded hull that was rapidly forming. The men watching understood. It was to be another cargo ship. Rapidly this hull grew under their swift manipulation, till it was completed in three and a half hours. An entire ship, except for the machinery, was completed. And now they began to work on another, and as they fell to work there started from the original cargo shops a long line of small, quick moving machines, machines that could run along the ground or drive through the air, and they were covered

with arm-like appendages. Soon these reached the newly built hull, and quickly they were at work, getting material from the strange squat machines, entering the hull, and working at it. The second hull was nearly completed when one of the smaller machines flew back to the original encampment and went up to the sphere. From it it drew a strange metal case, oblong, from which led a great heavy cable. This it carried back to the now completed ship and installed it somewhere inside. Then the ship rose easily from the ground and floated around a bit, landed again, and immediately there came out of it one of the torpedo-ship machines! None of these had gone in, it had been made by those slim, quick worker machines! And now there lumbered out a second machine—one of the strange hull maker machines—then two of the worker machines came out, where only one had gone in. The ship was complete, even to its strange crew! And now that strange crew was already at work, making others!

With the coming of dawn the televisors were rayed out of existence. But that evening more were installed, and every night during all that invasion there floated above them those noiseless televisors. They destroyed many, but many remained.

That night showed us a fleet of nearly a half million of the tiny torpedo-ships, and a rapidly growing cargo ship camp. There were more than a hundred now, for as each was completed, the machines made could aid in the more rapid construction of the next.

And that night they began their work of leveling Mars. That great fleet spread itself out over all the surface of Mars, and with flaming heat rays and the terrible Dis rays they cut down every remnant of the Martian hills. Twenty-four hours later the entire planet was one vast featureless plain. And on that plain there had been established eight camps. During this time the cargo ships had been moving, and during that twenty-four hours they did nothing. But Man was prepared. The radio-controlled fleet was ready to be given its first try.

The entire fleet was assembled above the surface of Mars, above that original camp, where still rested the one sphere. Then from far out in space the great control ships directed the dive of the radio-control-ships, making the distance one-twentieth part of a light second. The men directing the

ships were no faster than that, could not respond sooner, and the greater distance gave them greater safety.

But now the radio-controlled ships were released, and permitted to drop, uncontrolled. They wished to give the Sirians no warning. Then when the ships were scarcely ten miles from the Sirian fleet, they were brought under control, headed nose down in a power dive, straight through the surprised upper layers of the fleet, and with Dis rays glowing they drove straight for the ships below. Suddenly, there were great gashes in the ground beneath, and twenty of the cargo ships were gone in that first rush, and three more followed quickly. But while literally thousands of the Sirian torpedo-ships had been rayed, nearly half of the thirty thousand radio-controlled ships of Man were gone. And now they had to apply full power to prevent striking the ground. But twenty-two of them continued on in straight fall toward the great sphere. They were rayed by a hundred ships before they could get really separated from their companions. And now the fast radio ships were destroying hundreds of the Sirians, they were formed in a vertical column reaching up ten miles, one above the other, with the nine Dis ray projectors going full blast and spinning as rapidly as was safe lest the machines fly apart due to centrifugal force, for the Dis ray will work practically instantaneously. The top ship was preventing the torpedo-ships' attack from above. Suddenly each of the ships stopped spinning; its Dis ray went out and they dropped like rocks. The radio control had been drowned out by powerful interference; they were no longer under the influence of the men, and they had ceased to function. The radio-controlled-ships would no longer be useful against the Sirians.

Nearly the entire fleet of the Sirian torpedo-ships had been wiped out by that spinning column. Now thousands of the manually-controlled ships dove down at the weakened fleet. Every one of the remaining ships shot up to meet the advancing fleet; there were still several thousand of the torpedo-ships. And now the sphere rose with them, and among them. Suddenly the entire mass came together in the shape of a greater sphere with walls of torpedo-ships, and as it formed the torpedo-ships snapped on their Dis rays, and started the entire surface of the sphere spinning! They seemed

invulnerable in this formation, but they quickly moved away across the surface of the planet, the larger part of the Solarian fleet following, wondering what to do about it. It seemed impossible to attack the sphere of destruction.

But the cargo ships were left unprotected, and in a moment they had been beamed out of existence. The Sirians had lost many hours' work on this battle! And they lost more before the mighty fleet of torpedo-ships from the other camps rescued them. For now and then an explosive shell would penetrate the screen of disintegration rays. But within the outer shield was a second, virtually a shield of metal, for the metal sphere was surrounded by a solid mass of the torpedo-ships. But many of these were destroyed. More, too, were put out of commission by the copper crystals.

On the arrival of the great fleet from the other camps the tables were turned. The control ships had too low an acceleration, and there were too many ships for the ten-man machines to get, though they tried to make a screen of Dis rays that stopped the ships till they were rayed out of existence. Many of the control ships were lost and many of the ten-man ships.

It was then that Waterson announced two things that gave the Solarians new hope.

It was the fifth of August when the announcement was made. And it was the same day on which nearly the entire fleet from all the camps on Mars started off for Venus, but the movement was detected almost at once, and from great underground bases on Mars the Solarian fleet sent out fifty thousand ten-man ships. These ships skimmed along close to the ground, and their polished metal had been sprayed with a drab paint so that they seemed but shadows that became practically invisible as they sped along, widely separated, but rapidly converging on the site of the Sphere's camp. This had remained on Mars, guarded by so small a number of ships that it was evident they expected the Solarian fleet to go to Venus, as no doubt would have been necessary but for this swift counter raid.

So perfectly camouflaged were the Solarian ships, that they got within ten miles of the camp without being discovered. Then, as their Dis rays flashed out, the entire group of the torpedo-ships dove on them. There were nearly one hundred thousand of the ten-man ships, diving down at them in a zigzag course that made them impossible targets, but the fleet had been

approaching from all sides, and now the entire Sirian defense was concentrating on the machines attacking from the north. Those from the south crept in behind them, and suddenly the sphere started into the air, then went flying out into space at terrific speed. It barely escaped the Dis rays of the attackers. Only its tremendous acceleration saved it. Now several thousand of the torpedo ships shot after it, the rest falling into the form of a great disc to block the path of the pursuers. Man had long been accustomed to two dimensional maneuvering, but the ease with which these Sirians fell into complex three dimensional formations showed long practice in the art of warfare in space.

That raid was successful in that it forced the immediate return of the Sirian fleet, and very nearly destroyed the sphere. Over seventy-two thousand of the torpedo-ships were destroyed, but we lost two thousand ships and twenty thousand men. But Waterson announced that the Sirians would no longer be able to escape because of their greater acceleration. He had discovered a method for using an attractor beam of a short range but considerable power to be used with an electro-magnetic device that would automatically turn on the instruments in such a way that no matter what the accelerations might be, no matter how great, as long as they were within the limits of the ship's strength, the accelerations and centrifugal forces would be instantly neutralized, thus making possible violent maneuvers that the sudden forces had hitherto made impossible. A demonstration of his new ship had confirmed it. He took up a number of the Cabinet in his special machine, and turned hairpin turns at ten miles a second! The acceleration would have been instantaneously deadly had those neutralizers failed. They might as well have been under a half million ton freighter as it landed, as undergo those accelerations! But in that perfectly balanced room, it was not detectable. The ship's hull was made triple strength, as were the power projectors, and the generators. It was powered like a freighter, and could reach its full speed of 1,000 miles per second at an acceleration 5,000 times that of Earth's gravity. Waterson, who weighed two hundred and ten pounds on Earth would have weighed over five tons! It meant that the Solarian fleet would no longer be handicapped by the greater flexibility of the enemy ships. The plants that had been manufacturing the machines had already closed down temporarily, while the dies for these new machines were being made. But within thirty-six hours the first of the machines was being turned out.

And now a great crew of young men were being gathered to man them. They were all volunteers. There were to be one million ships, and that meant ten million men would be needed. Only modern methods could have made that possible, but with three populations, totaling over twenty billions, a sufficient number of volunteers came forward to make the work easy. As fast as these men came to the conscription stations, they were put into the new machines. And here also modern methods had helped. The Waterson system of material energy release had been so successful, that the price of a completed car had dropped to well under one hundred dollars for the small two-man machines. And even for the interplanetary models not more than two thousand dollars needed to be paid, for the raw materials were absolutely free, the labor was mechanically reduced to almost nothing, and as the energy that drove these machines was as cheap as the raw materials, they merely charged enough to make the venture pay a decent return on investment and to pay the wages of the few machine supervisors and the office staff. Men worked five days a week on three-hour shifts in the factories, but longer hours and more pay went to the builders, to the men who had to manually control the building construction machinery, for law forbade the building of offices on the mass production scheme, since that meant an unvaried, monotonous city. But everywhere wages were high, for wages depend, not on the amount of work men do, but on the amount of finished product they can turn out. The men accomplished more, and were paid more, but they worked less. It had taken many years to finally convince the Earth of that, but the example of American labor, with its shorter hours and higher wages was proof enough. And then the influence of the mighty energies Waterson had released made it even more apparent. Mars had already developed the system under the force of the released atomic energies.

High wages and cheap machines had meant that everyone owned one. And so absolutely safe were they that they commanded perfect confidence. This had been a big factor in the making of this mighty fleet. Everyone knew how to operate the machines, so it was easy to fill the places on the machines with pilots.

Nevertheless, special training was necessary to overcome the caution against quick turns that long experience had instilled in them all. Each accepted applicant was taken up in one of the new machines, and given a

breath-taking ride—a ride that consisted in diving toward the Earth with terrific sudden acceleration. Then, just when the student felt certain they would crash and become a mass of molten metal, the ship was brought up, not a mile from the ground, to settle gently; then, when they almost touched the ground, they leapt into the air again with an acceleration that shot them out of the atmosphere with the velocity of a meteor, while the outer wall of tungsto-iridium alloy glowed cherry red. Then came sharp turns at ten or twenty miles a second, till at last the students no longer gripped the arms of their seats in anticipation of a sudden acceleration. Then they were taken down and given a ship to experiment with.

But none of these men had ever handled a weapon of the sort they were to use, so mimic battle practice was held, with the glowing rays of a harmless ionizing beam instead of the deadly Dis rays.

Daily reports were coming from the Martian scouts as time went on. The Sirians, too, had decided to do some fleet building, for nearly three-quarters of their fleet had been destroyed. The production rate of man's factories, 120,000 a day, had gained a slight lead. It would require ten days before a fleet of a million could leave for Mars with a home guard of two-hundred thousand ships.

The destruction of the Martian plants had lowered the production rate to about 3,500 an hour, but shops put up rapidly on Earth and Venus had quickly brought the production-rate back, and it would be nearer 7,000 an hour by the time the last of the fleet had been finished.

The spinning sphere formation of the Sirians had been almost invulnerable, and an exceedingly destructive formation. The Solarians had chosen several thousand of their crack pilots to practice this maneuver, but despite almost constant practice during the entire ten days, it was a miserable failure as soon as they tried to progress. Standing motionless it was a very effective procedure, but the spinning column was decided on as more effective as long as they had no ship to protect. There were twenty groups that practiced that maneuver.

And then Waterson announced that an associate of his, working in his laboratory, had developed a method for using a triple electrical field to direct the Dis ray, making possible a ray with a range of over sixty miles. This would be absolutely fatal to the spinning sphere system of the Sirians. The Sirians very evidently did not know how to project the Dis ray any further than twenty-five miles. The ability to stand off and hit them would break down the sphere of Dis rays very quickly. There was only one objection. The rays were very powerful, so powerful that they required triple power generators, but the special field of electrical force was the worst problem. The field could not be made sufficiently strong if a single layer of the force was used, but the invention of a method to back up the first with two other layers of equal voltage, thus getting nearly three times the effect without exceeding the capacity of the insulation, had made the new machine possible. This special field was produced by circularly moving cathode rays, or exceedingly high velocity electrons, and therefore could be produced only by atomic methods. This meant ten thousand times the amount of fuel a similarly powered material engine would have required, but material energy of course yields only wave motions of the transient or unstatic type, a type that cannot stand still. Atomic energy can yield static-waves as well as unstatic; the electron can stand still, and is a perfect example of the stationary wave.

These limitations, in turn, meant that a tremendous weight of equipment was needed. And a corresponding great volume of space was required. In the end they had to use specially reinforced freighters to carry the great projectors, each of which could carry but two projectors. Due to their long range, however, the ships were at least self-protecting. There was not time to make and equip more than twenty-eight of these ships before the fleet was scheduled to start. They were completed ahead of time. Some of their trial trips more than fulfilled the best hopes of the inventor. Dr. William Carson, the physicist who developed it insisted that it was really Dr. Waterson's suggestions that made the thing possible.

We had learned something of spatial warfare formations from the Sirians. Now we were to learn a bit of the strategy of spatial warfare.

The Solarian fleet sailed for Mars on the fifteenth of August, 1961. They were a scant twenty million miles from their goal when a report came from a scout that something was happening down in the Sirian camp. Almost immediately after that the Sirians flooded our entire system with so terrific a barrage of radio frequency static that communication was impossible. They could not transmit from Earth to Venus, and the communication was very poor even from one side of Earth to the other, despite the fact that over a half billion kilowatts were used. So intense was this barrage, that if two of the torpedo-ships near the sending apparatus came within twenty or thirty feet of each other, great crashing sparks leapt across, and instantly they were fused. Scouts saw this happen twice.

The Solarian fleet continued on for Mars. They should cover the remaining distance—twenty million miles—in five hours by pressing the ships a little, although higher speeds made the rate of approach of asteroids so great that they frequently could not be detected before they collided with the ships.

Only two and a half hours later a scout came into sight at terrific speed. He must have been doing over two thousand a second, an exceedingly dangerous rate—but his acceleration neutralizer enabled him to slow down safely. He reported that the entire Sirian fleet had risen from Mars, leaving a very few machines behind—this time taking the sphere with them—and had set out for Earth! Earth was on the other side of the Sun—a long two hundred and twenty million miles to go! The Sirians had a lead of three hours. They had as great a speed as the Solarians and would reach Earth before the Solarians. But they would at least be delayed by the two hundred thousand ships—more now, for the steady production would have built the quota up to over six hundred thousand, or a million by the time they could return. The Sirian fleet had been built up to nearly three million though, which could easily crush the fleet of a million, and the second million later—separately. The trip would take them sixty-two hours. Scouts had been sent ahead to Earth at a dangerously high speed to communicate the news, and the entire fleet had increased its speed to a rate that was considerably higher than safety warranted, but a continuous play of Dis rays was considered sufficient safety at fifteen hundred miles a second. The Sirian fleet had been reported to be making thirteen hundred and fifty, so the Solarians should pass them, or meet them, just shy of the Earth, where the

other fleet would be waiting. They should have no difficulty to crush the Invaders with the two million ships.

The radio interference was being maintained by a ship anchored somewhere in space. It was no doubt well protected, and to attack it successfully would have meant the loss of a large number of ships, for the time spent in the attack would delay them irreparably. They must continue to Earth.

There were no scouts from the Sirian fleet—yet there should have been, for over a thousand ships had been following them, far behind. None ever reached Earth to warn the fleet. Every one of them was destroyed. But when the Sirian fleet was well on its way—it turned—and headed *for Venus!* They had purposely let that one scout reach the Solarian fleet with the news that the fleet was headed for Earth—then they redirected their course. The scouts from the Solarian fleet did reach Earth—but soon after the last of the scouts following the Sirian fleet had been destroyed, their radio barrage was lifted. All the ships on Venus were concentrated on Earth, and Venus was left unprotected.

Twenty hours after the fleet had turned back, the radio barrage was again lowered over the System. It was ten hours later that the Sirians reached Venus.

While the radio barrage had been lifted, Waterson had had an idea that there should be some protection for the planet. It did not seem that the planet should be completely stripped of its defenses, and he had suggested that at every city great Dis ray machines of the sixty-mile range type be set up. His suggestion was followed, and at every city on Venus the great machines were installed. There were many of them now, for during the hundred hours the main fleet was in flight the new machines had been put on a quantity production basis. But all the ships that were equipped with them, were sent to the defense of the unattacked Earth! And it was those machines that prevented the landing of the Sirians. They came to the night side of the planet, of course, coming from Mars. It would be thirty hours before they would be expected on Earth—thirty hours before the main fleet would reach the planet—and then there would be the 160,000,000-mile trip to Venus if they were to get there in time to rescue the planet.

But the Sirians could not approach within beaming distance of the cities, and all those that did try to do so, were brought down as a cloud of powdery

dust. It was Waterson's caution that saved the billions of people on Venus.

But were they to be saved? The Sirians decided they must destroy the works and the people on Venus, so they made one desperate effort. They had at least sixty hours to work in, and now they had a plan that would require time. They retired some hundred miles from the planet, then the entire fleet, torpedo-ships, cargo boats, and the entire body guard of the Sphere lined up, and then switched on powerful attractor beams. Immediately, the combined effect of over three million of these emanations took hold on the planet, and great tides began to rise in its mighty oceans. Many lives were lost in the seaside towns, when the tremendous waves rushed in over the land. But astronomers on the planet and most of the System's scientists were there to watch the Sirians on Mars through their great telescopes. And these astronomers saw what the Sirians intended, and saw that they were well on their way to fulfilling their aim.

A planet is balanced in its orbit about its parent sun with the delicacy of a diamond on a jeweler's scales. But, like the diamond, if it be displaced by some force, it reaches a new state of equilibrium. Thus, if the diamond is further lowered in the scale by adding a small weight, it soon reaches a new point of equilibrium. No conceivable force, therefore, could be great enough to displace the planet in its orbit more than a few million miles by pulling it either in toward the sun, or out from it, and as soon as that force was released, it would spring back to its original position as the diamond would regain its balance on removing the disturbing weight. For the sun pulls on a planet with a titanic force; it draws it in with the apparent force gravity, and another similar, but opposite force, centrifugal force of its revolution in its orbit, is constantly tending to throw it into the depths of space. These are the two forces that are always balanced. Suppose the planet is drawn nearer the sun; it revolves in a smaller orbit—and it revolves in that smaller orbit with a higher speed—for it has fallen in toward the sun; it has gained speed as any falling body would. It has gained speed in the direction of the sun, but this has operated to increase its rotational speed. Thus it has gained a greater centrifugal force—you can see the effect with a bit of chalk on the end of a string. The smaller the circle it

swings in, the greater the tendency to fly outward. But as long as we continue the force that was added to draw it in, it will remain in equilibrium. Remove this extra force and at once the planet will fall away from the sun, losing speed as it does so, till it has reached a point where it is once more in equilibrium with the force drawing it inward.

Now reverse the problem. Let us draw it away from the sun. Now the orbit is longer, and it has lost speed in moving from the sun. It cannot stay here, it is not in equilibrium, unless the force that drew it out is maintained. To free the planet from the sun, one would have to lift hundreds of quintillions of tons of rock through billions of miles, against the terrific gravity of the sun. It is too much.

Thus we see that as long as the planet revolves in its orbit, it will never fall, and to pull it away from the sun is impossible as long as it revolves in its orbit. But if it slows down in its flight about the sun it at once has less centrifugal force. It automatically falls toward the sun until it has gained velocity enough to establish a new orbit of equilibrium. If this energy, too, is withdrawn; if it is made to stand still in its orbit; it will fall straight to the sun. It is the only way such a thing might be done. And it would take the energies of matter, and strain that to the utmost, to accomplish it.

This was the plan of the Sirians. Three million ships were dragging like a Titanic brake on the planet as it wheeled in its orbit, and slowly, steadily it was falling into the blazing furnace of the sun. Their ships were not designed for this task, but they could do it in the sixty hours at their disposal. In a short time it would be falling directly toward the sun, but it would take many hours for the seventy-million-mile fall. Even if it were stopped before it reached the sun, any place within twenty million miles would be unbearable.

It was the distressed planet itself that warned the people on Earth and the men of the fleet that the Sirians would never reach Earth, for the radio was still dead. But the fleet turned for Venus at once. They were far to one side of the path to Venus, and they would have to turn, but it would take them thirty, instead of sixty hours to reach Venus. And the other fleet was coming from Earth. They were not quite a million strong, but those machines that had been produced on Venus would come also, and that would bring the total numbers up to over a million, and with the main fleet the number

would be well over two million. There were also three hundred of the long range Dis ray ships now, for many more had been produced and Venus would supply an equal number.

We can only admire the wise action of the Commandant of the Venerian fleet, Mals Hotark, in not sending his pitiful fleet of a few thousand out to fight with the Sirians. The members wanted to, the people of Venus wanted him to, but he wisely waited until he saw the fleets of the System approaching. It would have done no good, and lost many lives, and valuable ships to have gone in advance to the attack.

Many people tried to leave Venus, but enough machines were freed of the task of stopping the orbital motion of the planet to patrol the heavens and keep the people from leaving. They beamed thousands of private cars out of existence; it seemed unnecessarily cruel.

The two great fleets were drawing nearer to the planet, converging, and at last they got so close that they could carry on a radio communication by using the terrific power of over two billion kilowatts of energy. The amount of power that Sirian machine was throwing off has been estimated at a minimum of fifty billion kilowatts. We know that enough power could be picked up from a hundred meter aerial on Earth to operate a small, high frequency motor.

When radio communication was established, they agreed to wait until they could join, for the fleet from Earth was two hours ahead of the main fleet. The loss of time was made up for in greater efficiency of action. They would need it all. At last they joined fleets, one mighty disc of two million airships, they flew on through space at a steady rate of five and three-quarter million miles an hour. They arranged themselves in a mighty cone as they came nearer Venus. Already the machines had slowed it down so greatly that the planet was over a million miles out of her orbit, and rapidly adding to this mileage.

But now as the great cone approached, the great ships with the long range Dis rays leading, they were discovered. The cone formation was chosen, for

that is the three dimensional equivalent of the two dimensional V that man had used in war on earth for thousands of years.

Now began the greatest battle in the history of the System. Here were two mighty forces slashing at each other with terrific disintegration rays, fighting in the great Void, and five million powerful ships darting around, slashing, stabbing with a death that struck with the quickness of light.

As the great cone of the main fleet attacked from one side, there was a smaller cone attacking the Sirians from the other, but long before the Sirians could bring their rays into effect the long range rays had torn great holes in their ranks. The Sphere had retired with its escort at once, going swiftly to Mars. The main fleet was too busily engaged in fighting the Sirians' main fleet to worry about the Sphere at present.

A dozen times the great spinning sphere formation was tried by the Sirians, but each time a withering blast of the long range Dis ray cut it up as a tool held against a spinning block of wood cuts it down in the lathe. Their strongest formation was useless, and they could no longer outmaneuver the Solarians, the new ships could turn and dart as quickly as they, or even more quickly. The big Dis ray ships were not equipped for fast fighting, so when there were none of the spinning sphere formations to break up, they retired to a safe distance, and waited for any ships that might attack them. Few did. It proved suicidal. But steadily the forces of man were conquering. In a hell of flashing Dis rays, the new ships were proving their worth. The flaming rays had seared the land below for many miles, but the fleet of the Sirians was fast going. The new fast ships of man could dodge the rays of the Sirians, turn and dart on the tail of their attacker, then hang there, the attractor beam giving them an added grip until they could flash the machine into nothingness with the Dis ray. They turned, ducked, darted ahead with terrific speed, suddenly stopped, and then were going full speed again. And another Sirian ship was gone. Now it was the delicate apparatus of the Sirians' ships that suffered; they could not keep up with the sudden turns of this flexible adversary. And their great fleet had been reduced to a scant quarter million, but we had lost nearly a half million ships, five million men, in that Titanic struggle. Such a battle could not last long. It was impossible. Nothing could stand before the Dis rays, and with those turning, darting ships, sooner or later every ship must come under the influence of those rays. But now the last of the torpedo-ships were fleeing into space.

But we did not care to have to fight them again—and they too were rayed out of being. They could no longer dart away from us before we could catch them—that was for us now!

But now the fleet returned to a greater task. Venus had been falling toward the sun, and was nearly a million and a quarter miles off and within her orbit. Now a great fleet of cargo carriers from Mars, Venus and Earth came up, and with them came wrecker ships, capable of picking up on their powerful attractor beams an entire million-ton passenger-freight liner—great liners themselves, all equipped with attractor beams. Soon they were all using their power to bring the planet back to its normal speed. It did not take the ships of that mighty fleet, many specially designed for heavy listing and towing, many designed for tremendous loads, very long to bring the planet back to its age-old orbit.

In former days we would have found a world wrecked by panic. But this later generation had learned to trust in the powers of the ships they had, and there had been little of the terrible panic that would have affected the world of a generation ago. Then, too, they knew that with the demonstrated power of the long range Dis rays, they could safely convoy a fleet of the great passenger liners to safety.

What helped also was the fact that the human mind cannot grasp the full significance of the fall into the sun. If you were told that the planet you were on was sinking toward the sun, you would be surprised, horrified, and would probably try to make a bargain-buy on real estate, while the other man sold his to get his money out. You would simply fail to comprehend the magnitude of the catastrophe. It has never happened, and never will, the mind says, and we unconsciously believe it. Your neighbor would joke about it to you. Of course many would leave, but most people would stay till the actual physical heat of the sun drove them off. We are constituted that way.

But now the radio barrier was down, and news from the Martian scouts made men hesitate. The remaining cargo ships had settled on Mars and were even now pouring out their strange crews. But they were not building cargo ships. Every one of the worker machines were kept in action constructing duplicates of themselves as rapidly as possible. Already a great number of them had been made—over seven hundred of the machines it

was estimated—and now these were engaged in similar work. The number grew in a steady geometrical series.

But the scouts were driven away by the torpedo-ships. Then there was no news of the operations until nightfall permitted the scouts to creep up and install the usual floating vision machines.

Then at last we understood the reason for this tremendous number of inoffensive worker machines. There was a great seething mass of metal around the workings now. Great blazing lights illuminated the scene as brightly as day. There was a great horde of shining metal machines working swiftly about the great plain. There seemed to be thousands of them now, and they were all busily at work on great machines—the torpedo-ship machines! There must have been nearly a thousand already completed and already the fleet that had escaped had been built up to many thousands by the rapidly working machines, and a steady stream of long glistening shapes rose—only to be lost in the darkness beyond. Steadily the great machines were being put together, and steadily the great fleet was being augmented.

Before morning that fleet had reached two hundred thousand, and was now growing at the rate of twenty-five thousand an hour. Steadily this rate was increasing. The fleet was too large to be attacked by man's weakened fleet, for the delay in putting Venus back in its orbit had given the Sirians a chance to build up an invulnerable fleet. The added time of the trip to Mars meant a still greater fleet. Already their production-rate was far greater than Man's. Man could not hope to compete successfully. We were learning the meaning of quantity production.

Had it been possible to attack them with the long range Dis rays it would have been tried, but the plan was hopeless. Before the fleet could reach them there would be 100,000,000 miles to go to reach them, and it would take approximately twenty hours, in which time, at the present rate of increase, the Sirian fleet would have reached a total of three million again. They would all concentrate their attack on the long range Dis ray ships. No Solarian ships could help without interfering with the action of the Dis ray ships, and they would need help, for each ship carried only two beams. More could not be carried. They would merely be held at bay, unable to attack their goal, useful only in breaking up the spinning sphere formation, but that could be prevented. The Solarians had learned that trick from the

Sirians. The Sirians had succeeded in breaking up every spinning column formation by simply getting into the midst of it before it was formed completely. It required perfect coordination of several machines to do it, but it was always done. The long range Dis rays were excellent now in defending a city, but useless for attack because of the terrific weight of the apparatus. They could not attack the Sirian fleet. If they did the production machines would have been so built up by the time they reached the planet that any ordinary rate of destruction would be easily equaled by the production! Within three days it was decided that the Sirian fleet would be built up enough to attack. They would then attack our planets, no doubt.

A cabinet meeting was called at the Waterson laboratories on Earth. There Waterson first demonstrated the weapon that finally conquered in the terrific struggle. Before the members, on the Cabinet table, was a small portable material energy disintegrator, a machine that gave off its energy as light. There was a second machine at the other end of the table, a machine that occupied about two cubic feet of space, and on one side of it was a small switch and a dial; on the other was a familiar looking projector.

Dr. Waterson spoke:

"Gentlemen of the Cabinet: I have here a new machine that my laboratory has developed. I will demonstrate its action first." The light was switched on, throwing a brilliant shaft of light against the ceiling. Then Waterson snapped on the switch of the new machine, and there appeared a strange beam of blueish, ionized air. But unlike any other known ionizing beam, it was shot through with streamers of red fire, long, hair-thin streamers that wavered and flickered in the blue tube of the ionized air. It reached out, touched the light generator, and passed on, through a series of plates of different materials. But the instant that strange beam struck the light-machine, it went out. Then a moment later, when the new machine was turned off, the light snapped back on.

"Gentlemen, this machine will produce a field, directional in this case, that will so modify the properties of space as to make it utterly impossible to disintegrate matter into energy. There is some tendency to fix energy as

matter. I think that will be interesting to us in the event that this war is successfully concluded. But at present we are interested in the properties of the beam in that it will stop the disintegration of matter. The process depends on the modification of the properties of space. It is well known that in ordinary space, such as we know, there are twenty coefficients of curvature. In ordinary empty space, ten of these have zero values, and the ten principal coefficients have certain non-zero values. This machine so affects space that it makes all the coefficients of space have non-zero values, and fixes these values to suit its own purposes. The results are amazing. I have done some things with this machine that makes me truly afraid. But we are interested in it because certain of the values we can assign operate to force space to take such curvatures, that any change of the condition of matter to condition of energy is impossible. On release of the ray, the space returns to its normal curvature.

"Working out the theory of this machine has been a tremendous task. Even the great calculating machine, the new integrator developed last year, and it is a far cry from that first one that M.I.T. developed in 1927, required many weeks of work to solve the problem in twenty coefficients of space. In so doing at one stage we had to assume a space of twenty dimensions in order that the correct values in the four true dimensions might be determined.

"But there is still a great deal of work to be done. We must develop practical machines of a range of many miles. There is no difficulty in using the ray, since, as it is a condition of space, not a vibration, it is impossible to stop it by any shield. There is only one way to work with it, to create it directionally. We make the field by projecting certain strains along a beam, then once started the field follows that line to a distance dependent on the strength of the generator.

"But this will require at least five days to get into working form. I suggest that in the meantime Venus makes several million of the long range Dis ray projectors, and distribute them all over the planet, to be turned on from a central station, or by their own separate crews. I have no doubt that the Sirians will attack that planet before we are ready to attack them. Earth, too, must be prepared. But in the meantime we can begin the work on the new de-activating field projectors, as I call them."

Waterson was right. It was three days later that the Sirian fleet left for Venus with a number of torpedo-ships so tremendous, it is absolutely inconceivable. There were over two hundred million of the ten-man machines! When they started to settle about Venus, the sky was so filled with them that it was literally dark for many miles. They attacked at Horacoles the System Capital, but the fields of the great Dis rays were too much for them. Neither bombs nor Dis rays could reach through. The air was dense, and filled with artificial smoke to prevent the transmission of heat rays and great winds were created for the purpose of carrying the heat away; but this was done automatically by the expanding air before long. They could not attack the city. All over the face of the planet were the great Dis ray emplacements. Great ships hung even over the great rolling oceans, sending the blue rays of ionized air up like some column that was to hold the Sirians from the Planet. And they did.

But now again they began to slow down the planet—not gently as they had had to before—but rapidly. The planet would have been pulled to pieces, except that the very attractor beams that were pulling on it tended to relieve the stress. But the cargo ships of Venus were pulling to keep the planet in motion. It was a strange thing to contemplate! Two mighty forces, one a fleet of two hundred million small ships, the other a force of as many thousand huge freight carriers, having a tug-o-war for a planet! But the odds were too great. Slowly the Sirians won. The planet was steadily dropping toward the sun. Now it seemed no fleet could come to aid them, and the Sirian fleet was being augmented constantly by a steady stream of ships from Mars. It was the sixth day after the announcement was made that Waterson had a fleet ready to attack the Sirians. The Venerians also had a fleet ready, prepared by the directions of Waterson's engineers sent by radio-television and radiophone. They were ready to attack, and the

Terrestrial fleet arrived at Venus just six days after the announcement of the new weapon.

The practical projector of this new ray had been quite heavy, and they had been mounted in groups of twenty projectors on special hundred-man ships, using the same acceleration neutralizer used on the ten-man ships. They were arranged to throw a wide beam, so wide that the new ships with twenty, could prevent any action in a field of over two hundred miles depth, and in a cone with a base of six hundred miles diameter. The ships they had could approach within a hundred miles of the Sirian fleet, without being seen, for they were painted black therefore and showed no lights. In the darkness of the void they were easily hidden.

The entire expedition went as planned. The radio barrage had not been turned on, and they were in constant communication with the Venerians. The two fleets were to attack simultaneously, over different areas, so that between them they could wipe out so large a number of the enemy ships that the fleet of two million could easily handle the task.

Hidden in the utter dark of the void they crept up on the Sirians. They were in the sunlight, but the black coating kept them invisible, while the Sirian ships shone brilliantly. Then at last the tip of the great cone formation was within easy striking distance of the fleet. There reached out the strange ray, and here in space it was utterly invisible. But suddenly the ships within its range began to waver, to fall together under mutual gravitation. With one swoop they all shot toward the ships in space that had paralyzed them, for the attractor beams had been turned on them. As the great mass of ships fell rapidly toward them, long range Dis rays reached out, and they melted into clouds of shimmering dust. Great swaths were cut through their ranks. A similar scene was taking place far to the left of the Terrestrial fleet where the Venerian fleet was working havoc among the invaders. Now the last of the ships had been rayed into nothingness and a great fleet of the Sirians were rushing forward to attack for the ships invisible on account of their black line had been electrostatically located now. But as the Sirians came within one hundred miles of the other fleets, the ships all ceased to accelerate, to change direction; they just drifted straight into that cone of

Dis rays. All walls of the de-activating field were lined with the ten-man ships, their shorter range Dis rays prevented any Sirians from escaping. Bright lights shone out on the Solarian fleet now—they wanted the Sirians to attack. The original cone formation had shifted rapidly; now it was a double cone; then it changed to a quadruple cone. There were six hundred of the de-activator ships and these were arranged so that they shot their rays off in four directions, making four cones of de-activated space, with the fleet of de-activator ships at the apex. Thus they were protected on all sides, and quickly, as the Sirian fleet spread out, more ships rose and there were six cones branching out. In the center rested the main mass of the fleet, the long range Dis ships, their attractors pointing out into the cones to draw the disabled ships of the Sirians into the range of their Dis rays, emanating in thousands from the ships lining the sides of the de-activated cones of space. The fleet was invulnerable and so sudden and complete was the failure of their power in these de-activated regions, that they did not seem to have time to warn their fellows. Many millions of the ships were lost before the wild charge could be checked; then the six-cone formation entire began to move slowly around; the Sirians, waiting to see what was to happen, were caught before they were aware that they were in danger. Many, too, were caught by the powerful attractor beams of the heavy ships within—drawn in by the greater power of the heavy ship, till their power failed. But at last the Sirians had learned the effective range of this new power and tried hard to avoid it. The six-cone formation was immediately broken up, and the six hundred de-activators went out individually, each followed by a swarm of the ten-man ships to disintegrate the ships caught in the de-activating cones. The Terrestrial ships were marked by a blazing blue light, so that if they too were caught in the de-activating field, they were not disintegrated. Only those around them were, and they were then released, as the ray did not seem to have any injurious effects on man, except to give him strange dreams. In some way the brain was stimulated by the ray, as long as the ray was used.

The de-activator ships were completely self-protecting; they could stop any number of attackers from any direction, provided the paralyzed ships were disintegrated as soon as caught, for if too many were piled up, the tendency of the matter to disintegrate in the engines, plus the natural tendency of the space to resume the normal curvature, caused the ray to become ineffective as it was overpowered, and one ship was lost in this way. Too many ships

piled up, and only part of them could be rayed out by the ship itself, and there were not a sufficient number of helping ten-man ships. But the mighty fleet of the Sirians was already beaten. They still outnumbered us ten to one, but they could not fight this new force. They began a running fight to Mars, and now the Solarians were united. Rapidly they wiped out the edges of the fleet, and gradually worked in toward the center. But the Sirians could not fight back—they could use only the explosive shells, and few of them reached their goal. They were disintegrated, or missed. Not more than three thousand men were lost in that entire engagement.

But now the Solarians tried a plan to capture the Sphere. A large number of the ten-man ships dropped out of the main fleet, but not enough to make it noticeable to the hard-pressed Sirians. These were joined by one hundred of the de-activator ships. Then these, all capable of higher speeds than the main fleet, set out at the highest speed that could safely be maintained, and darted toward Mars. Undetected they rushed past the Sirian fleet and passed on toward Mars. They reached the planet fully three hours ahead of the main fleet. By the time the main fleet had arrived, it came unattended, for the last of the mighty fleet of two hundred million torpedo-ships had been turned to impalpable dust, floating in space.

The advance guard arrived without warning, and as they had expected, found the Sphere resting on the ground, protected by a great fleet of the torpedo-ships. There were nearly a million ships there, with the great machines rapidly making more. However, all were grouped in an area that could be covered by the cone of the de-activating beam. And out in space, the ship commanders decided on a plan. Fifty of the de-activator fleet took positions high above the Sirians, and the rest went with the entire fleet of the ten-man ships. These were to approach the camp from the ground. Lying close to the ground, they would be hard to see in the disappearing light. At a fixed moment, all the ships above were to turn on their de-activator rays, which would be plainly visible in the Martian atmosphere, while the ground fleet of fifty de-activators were to use their rays from the side. The ten-man ships were to form a circle around the camp at a safe distance from the de-activator rays, for they would crash when their power failed, if they were caught by the de-activator rays. But they wanted to capture the sphere in good condition, so they arranged to have the space directly above it unaffected by the de-activator field, lest some torpedo fall on it and destroy

it. This would leave an exit for the torpedo-ships, except that at a point a mile or so above the Sphere, a cross-ray made escape impossible.

The rays were turned on. Instantly the fleet of nearly a million torpedo-ships fell wildly out of control, down through the blue glowing air, in which great streamers of glowing red seemed to waver and twist. Just outside the curtain of destruction waited the entire Solarian fleet. Slowly they closed in till their Dis rays swept all the ships within sixty miles of the edge out of existence; then rapidly the de-activator beams were forced ever sharper and sharper, till at last only the Sphere and a few hundred of the torpedo-ships, several hundred of the torpedo-ship constructors, and the corresponding cargo ships and worker machines were left. These had been saved for investigation by the scientists, for they were helpless.

But the war was over now. The Sirians had been destroyed, or reduced to mere museum pieces. Now the Scientists came to investigate the Sphere. There was much we wanted to learn from the creatures of the Sphere. But it was a strange story that the Sirian sphere had to tell.

Aeons ago there lived on a great planet of Sirius a race of intelligent men, shaped as we are, but smaller due to the greater gravity of their planet. And these men had developed a high civilization, a civilization different from ours, in that they learned early about mechanics, but chemistry and physics merely developed from the needs of the great mechanical engineers. Electricity was used as a powerful aid in their machines, and in their processes; it was a by-product, not an end.

Gradually their machines eliminated more and more of their work; they became more and more complicated, but more and more trustworthy. Men began to experiment with physics and found that their calculating machines needed development. It was easy to add first one step, then the next. More and more the machines could do. The mathematics became more and more complicated, and the machines developed the equations, found they could not handle them and passed them out as unfinished results. Finally one man used the machines to calculate the design of a machine that would be able to do these new equations. He built it, but the calculations were wrong. The

machine had correctly solved his problem, but he had stated it wrong. It resulted in a machine that would solve only simple problems, but it did something no other machine had ever done. Given irrelevant data it would choose the correct facts and solve the problem. It was a step, a short step toward a machine that really thought.

Progress thereafter was rapid. The machines built machines, had been doing it for decades in fact, but now they did one thing more—they designed them. Now the problem could describe the type of machine needed, and the worker machine would design it, and turn out the completed machine! But these machines were rapidly perfecting the beginning that man had made. Within a decade after that first discovery of the principles of mechanical thought the machine was made that could not only solve problems, but could also originate them. They had developed a brain. It was a great machine, which occupied an entire building, with its massive framework bolted down to the ground.

Man began a rapid decline, for the machines did all his work. With the construction of a machine that could originate a problem, man made a mistake. He had created a machine that was more powerful than he, except that it was immobile. And this machine originated a new machine, a machine that would release the energy of matter! It had developed this because it had been able to see that such energy existed. Man's machines could have solved it long ago, but the problem had never been stated. Now came a machine that could state its own problems—and solve them.

And with this new energy it designed a new brain-machine. A brain machine such as no man's brain could conceive—a machine that could move! For it was powered by the energy of matter, and could move as no other machine had ever moved before—out into space!

Still the machines worked for the Sirian man, and he learned of the new discovery, and began to design a new brain-machine.

Some of the Sirians realized the danger that was facing them, and they had continued long researches on man's brain, and at last had discovered the secret of giving a machine that emotion we call devotion, loyalty, or gratitude. And they built a great machine on that principle and used material energy to power it. It was a success. It could think original thoughts. It pointed out the danger of the existing machines—they were stronger than

man. It was only man's mobility and ability to control all mobile machines that had made him superior, for a brain without a tool, or body is helpless. And now that was lost. The existing brain-machines should be destroyed, and new ones built, using the principles that it was designed on.

But the mischief was done. The new brain-machine, designed by a machine, had done it. A machine had been built that was controlled by thoughts, a machine that could be controlled by the machines. Each of these machines was given a small brain, equipped with televisor sight and hearing, and it was powered by material energy. They could run for years without outside care, for the thinking machinery they had was sufficient to keep them oiled, and to make them seek repairs when they were damaged. They were susceptible to thought forces, and did as the thought waves suggested and reported to the control brain exactly what was going on about it.

And now this new brain developed a space-flyer to carry these machines, and man could not help knowing, for its every thought was recorded, for man's use. Then one day this record was found destroyed. The next day the brain-machine had left the planet, and taken with it the new space-flyer and the new telepathically controlled machines.

To the outermost planet of the System of Sirius the great machine fled. For years it remained there waiting, thinking. Then at last it called its worker machines into action. A new machine grew up from the stores of metal that the space ship had brought with it, at last the metal was used up, and the machine was not completed, so the space-flyer was sacrificed for the completion of the machine. The new machine was started. From its lip-like spout there poured a steady smooth stream of molten metal, and the rock on which it rested was eaten away. The first transmuting metal producer was made.

Decades passed, and only a small percentage of man developed. The rest sank deeper and deeper into a life of ease. The planets were all explored by the hardy ones, and no trace of the brain-machine was ever found, for it had discovered the Dis ray, and sunk deep into the ground, hollowing a great cave to live and work in.

But back on that planet, the scientists had developed machines that surpassed it in power, and finally one of these picked up a thought message from that distant machine that told its story. It was a thought that had not been consciously radiated, only the marvelous sensitivity of this new machine could have detected it, but now the men knew. It was too late to do much to prevent it, for they had no weapons. But the machine did. It was preparing to drive man from the planets, to rule there in his stead, with a population of machines!

The scientists quickly built a great space-flyer, a gigantic machine of over ten miles diameter, a huge sphere. And in that they established laboratories, workshops, machines, and living quarters. They took with them the finest men and women of their race, and sailed out into space, taking an orbit about the sun of Sirius. They were comfortable there in an equitable temperature, their ship lighted by the sun on one side, and dark on the other, steadily revolving on its axis like a miniature world. The foods of the people were chemically prepared, for the brain-machines had taught them how. The air was repurified constantly by machines that regulated the percentage of the gases to the thousandth of one per cent. But the entire ship was painted black. It could not be discovered floating there in space, so tiny in the vastness of a system!

It was two weeks after they sailed that the machine-brain attacked. It sailed out of its hiding place with thousands of great ships, armed with Dis rays and with explosives, with heat rays and attractor beams. The population of those worlds was wiped out in a week, and the rule of the Metal Horde began.

The original brain built other brain-machines to direct its affairs on other planets, and to do the work it did not wish to do itself.

For nearly a century those men lived in space, making swift forays on a planet with a fleet of cargo ships, that revolved about the main ship like satellites when they were not being used. In these trips they would bring back tons of rock, and leave most of it stored in the ships, dumping them into the reservoir of the parent ship when it was needed.

Then a swift ship was developed. A ship that could start and stop more quickly than any made before—a ship with acceleration neutralizers. But the machine brains of the Metal Horde never learned the secret. With a

small fleet of these, the men drove an attack at the unprotected main brain-machine. There were no men known to live in the system. No other known machine could move without the knowledge of that main machine, but these could. They too had the Dis ray now, and they destroyed the main brain-machine. They were lost in the ensuing fight, but that machine was destroyed.

All the remaining machines were equally powerful. Any one of them could have built a brain-machine that could easily conquer the others—but it too would have to bow to its creator. They fought it out. The men had known this would be the result.

It was a war such as the system had never before seen. Each force was equal, and could not ally itself with any other, for the machines could not lie or state other than their thoughts, and each wanted supreme power. They developed new weapons, weapons whose strength lay in their number. One by one the machine brains had gone down to defeat, the men of that ship helping to disturb the balance of forces by ever so little, yet always enough to throw one side down to defeat, yet always remaining in hiding. At last there remained but one machine-brain, and its weakened force necessitated its return to the devastated planet. With the destruction of the other brain-machines, the remaining machines that they had previously controlled, automatically obeyed the new master as perfectly as they did the old.

They returned to find a new fleet awaiting them. But it was not a vast fleet such as they had encountered before. At once the torpedo-ship machines settled to the ground and began turning out their weapons. But it was all over before they could enter as an important factor. These ships had a new weapon. It was a ball of glowing blue light that was driven along a beam of some vibration, and as it touched any ship, the ship instantly volatilized so suddenly as to constitute an explosion. The balls of light lasted about a minute and a half each, but were replaced as quickly as they were used. When they were finally used, they would die down to a dull red glow, then suddenly wink out. They could be swept from one ship to another, taking toll of ten or twelve ships each, and the beam that guided them could drive them with the speed of light and supply an infinite acceleration. They were glowing balls of concentrated energy of some sort, and as such could travel with the speed of light.

But they were effective to the *nth* degree. The entire fleet of that one remaining brain-machine would have been lost, but it retired into space, racing away at top speed, out into space, with the remaining remnant of its great fleet.

And sixteen hundred years it had raced across space, to be destroyed at last by another race of men. The battle was over, and the machine awaited its destruction.

We rayed it out of existence. It was too great a menace to keep.

Some people still do not believe that those Sirians were truly machines. They can not believe that a machine can have intelligence, but certainly Waterson's calculating machine has intelligence of a sort. And they ask, what would a machine want to exist for? It would have no aim, nothing to perform. Why should it want to live, or exist?

We might ask what it is human beings want to live for. If there is an after-life, it is certainly not that that we live for. I am sure no man wants to die. Yet what aim have we? What function must we perform? Why should we wish to live? Our life is a constant struggle, the machines, at least, had eliminated that. There seems to me no reason why a machine should want to live, but certainly it has less reason to pass out of existence than we have!

That war was destructive—terribly so. But it has brought its compensations. More than fifteen million human beings lost their lives in that great struggle, either in the battles in space, or caught in the Dis rays during that battle on Venus.

But those fifteen millions have died a painless death, and twenty billions live because of their sacrifice. And it was not a vain sacrifice. We have learned much in return. No machines man ever made equaled the machines we captured there on Mars. And man will never experiment on the lines of the machine-brain. He has been warned. The brain-machine we captured was destroyed without investigation. The machines we use, the wonderful worker machines, have been modified to permit of radio control.

And Stephen Waterson's discovery of the de-activating field not only helps in law enforcement, but makes war with material energy impossible. No, in all, we have lost little.

Mars lost its cities, its forests, its ancient civilization. New cities are being built on the modern plan, larger, finer, more beautiful; the forests are being replaced; but the records, the relics of a civilization have been lost forever. In that we have lost much. Though all moveable things were moved when the warning came, there was much that could not be moved. The great palace of Horlak San was destroyed, but it is being rebuilt in the exact spot, in exactly the same manner. It is a worth-while project, but there is much which cannot be restored.

It will be eleven more years before we will know whether we can ever communicate with the Sirian men. The speed of light is too low for rapid communication, and as the first signals were sent out in September, 1961, and it is now September, 1968, the signals are not due to reach Sirius for two years more. Then it will be 1979 before we can hope to receive their reply. I often wonder if they will ever get those signals. I can remember distinctly the recoil of the great projector as the mighty surges of light flashed out across the universe. It seemed like some great gun—the back pressure of the light was so great. And what will those replies tell us? It is interesting to speculate on that subject.

The End

*** END OF THE PROJECT GUTENBERG EBOOK THE METAL
HORDE ***

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