

FOUR DIMENSIONAL SURGERY

by Bob Olsen

Author of "The Four-Dimensional Roller-Press"



Just as I grasped it, the last of the screws holding the light fixture gave way, and with a jerk that almost pulled my arm out of its socket, the entire strain was shifted to my body. . . . Gradually more and more of the Hyper-Forceps came into view, until it was entirely visible. . . . As I slowly drew it toward me, first the right arm, then the torso and leg, and finally the head of Doctor Mayer loomed into view. His left arm, except for a small part close to his shoulder, was still invisible, however.



“SOMEONE said that ‘Fame is a fickle jade.’ She certainly has been inconstant to me, judging from the events that occurred subsequent to the mysterious disappearance of William James Sidelburg and his four dimensional roller press, which I helped him build.

Though I was fully exonerated from all blame in connection with the tragedy, the enormous amount of publicity I received as a result of it proved almost as disastrous to me as the fabled ‘golden touch’ of King Midas was to him.

When Sidelburg vanished, so did my job, and I had a dickens of a time landing another. Wherever I applied, I found that the story of how I had assisted the precocious young mathematician to build a machine which had expanded his body to enormous proportions causing him to drift away like a balloon, had preceded me.

I answered countless advertisements for work I knew I could do well, only to be turned down the instant I gave my name. I finally managed to eke out a few dollars by writing articles and stories for scientific magazines, but my income from this source was small and uncertain.

When I had almost reached the point of worrying over how I was to pay my small weekly bill at the cheap boarding house where I had been living, I was surprised one morning by distinguished visitors.

As I sat writing in my tiny bedroom, the boarding mistress brought a card to me. I could hardly believe my eyes when I read:

PAUL J. MAYER, M.D.
Mayer Brothers' Clinic
Winchester, Wisconsin

Who has not heard of Doctor Paul Mayer, head of the Mayer Brothers' Clinic, famous the world over for marvelous feats of surgical skill?

“Show him up at once,” I shouted to the landlady.

“And how about the other gentleman?” she stammered stupidly.

“The other gentleman? Is there more than one?”

“Yes, but he didn't give his name.”

“Well, for Heaven's sake, show them both up. And if there are any more, let them come too. But hurry, please! You mustn't keep them waiting.”

When Doctor Mayer and his companion appeared, I was again astounded. Before he could start an introduction, I reached out my hand and said, “Professor Banning is already well known to me. He probably doesn't remember me, but I studied calculus under him three years ago.”

“Oh, yes, I remember you very well,” rejoined the professor, though I suspected that he said this merely out of politeness. “And, since I know you, permit me to present you to Doctor Paul Mayer.”

“I certainly appreciate the honor of this visit,” I said, in all sincerity. “Professor, please be seated in that rocker. Doctor, you take the chair. I'll sit on the bed.”

If you happen to be a mathematician, the name of

Professor Banning will be just as familiar to you as that of Doctor Mayer. In their respective fields, both men are at the top of the ladder. Professor Banning has several mathematical accomplishments to his credit, which have made him internationally famous. He is best known as an authority on non-Euclidian geometry and on the fourth dimension, in which branches of mathematics he stands supreme.

Among laymen, William James Sidelburg was perhaps the best known exponent of the fourth dimension, due largely, without doubt, to the publicity he had received because of his youth and precocity.

Professor Banning, on the other hand, was little known except among mathematical scholars. He had begun the study of the fourth dimension long before Sidelburg was born and had succeeded in working out formulas and constructing models of four dimensional objects far ahead of anything that had been accomplished up to that time.

You can imagine how insignificant and how embarrassed I felt as I entertained these two distinguished personages in my poorly furnished, tiny bedroom.

Doctor Mayer started the interview with, “I understand that you are the originator of the four dimensional roller press.”

“Hardly the originator,” I hastened to correct him. “The idea was conceived entirely by Mr. Sidelburg. I was merely his assistant. He hired me to work out the mechanical details of his invention.”

“So much the better. If you could do that for one mathematician, it ought to be equally easy for you to do it for another. Am I not right?”

“I suppose so,” I stammered, hardly knowing what he was driving at.

“Well, that's what we came to see you about. You may be interested in learning that the immediate cause of our arriving at a very momentous decision was a phrase in your story, THE FOUR DIMENSIONAL

ROLLER PRESS, which appeared recently in a well known magazine. You quoted Sidelburg as saying that if it were possible to move in a fourth dimension, a doctor could remove an appendix without cutting the patient's skin.”

“That's true. He did say something of that

sort,” I responded.

“And, according to Professor Banning, it is entirely possible. But perhaps I'd better let him tell the rest of the story himself.”

Thus the professor picked up the conversation: “A few days ago, I took a trip to Winchester and placed myself under Doctor Mayer's care. For some time I have been troubled with gall-stones, and I was told that if anyone could help me it would be the Mayer Brothers. After examining me, they advised against an operation. They said that because of my advanced age and the weakened condition of my heart there was not one chance in a hundred that I would survive a major operation of the ordinary sort. It was then that I showed Doctor Mayer the passage in your story which he has just mentioned. After giving him a brief explanation of the theory of hyper-space, I asked him if such an

operation would be possible from a medical standpoint, providing the mathematical and mechanical features could be worked out successfully.

"He assured me that if I could provide him with instruments having four dimensional extension and capable of motion in the direction of the fourth dimension, he could perform even the most complicated operations without the necessity of cutting the skin of the person operated on. Naturally, the thing that interests me most right now is the possibility of having my gall-stones removed without the shock and dangerous strain that would result from an ordinary operation. They have been giving me a lot of trouble lately, and one of these days they will kill me. My life would probably be prolonged a great many years if I could get rid of them. This would enable me to devote myself to perfecting a complete set of four dimensional surgical instruments, which should be the means of saving untold pain and hardships to afflicted humanity.

"The reason we have come to you is that both Doctor Mayer and I are entirely lacking in mechanical skill. You, on the other hand, are an expert mechanic. Still more important, you have the inestimable advantage of being the only person we know of who has actually constructed a four dimensional object. For these reasons, we are asking you to help us make some four dimensional surgical instruments. Will you do it?"

"I hardly know what to say," I faltered. "Naturally, I know a little about the fourth dimension, but what you have just told me is away beyond me."

"Perhaps I'd better explain it more in detail."

"I wish you would."

"The best way to get a clear conception of the possibilities of hyper-space is by analogy, as, for example by comparing the characteristics of three dimensional objects with the limitations of other hypothetical inhabitants of space having but two dimensions—or even only one dimension.

"Imagine a creature like a very thin worm, so thin, in fact that it might be considered as having neither width nor thickness, but only length. This would be a one dimensional being, sometimes called a Unodim. It could move ahead in a straight line and could back up along the same line, but would be absolutely incapable of moving either to the right or left, or up or down. To imprison such an animal, you need only put a grain of sand in front of it and another behind it and it could not move either around or over them.

"Now, suppose we add another dimension, namely width. We now have a being of two dimensions—a Duodim or Flatlander—whichever nomenclature you prefer. About the nearest approach to such a creature in nature would be a very flat flounder or turtle. But while a turtle has a very appreciable amount of height, the imaginary inhabitant of 'Flatland' would be thinner than the finest tissue paper or gold leaf.

"The movements of such a creature would be confined to a single plane. It could move forward and backward, to the right and left, but it could not move either up or down. In order to confine it, you need merely to enclose it in a circle drawn with a lead pencil and the Flatlander could not get out of the circle unless he were able to break a hole in the ring by removing some of the graphite.

"Suppose there were two such creatures inside the circle, and suppose a three dimensional being like yourself should pick up one of them, move it through the third dimension and place it outside the circle. To the other Duodim, its companion would seem to vanish in an inexplicable manner. If he were able to break through the pencil mark and discover the other Flatlander outside, he would be completely baffled to explain how he managed to get there.

"Assuming that there is such a thing as a four dimensional being, it would be just as easy for it to lift you out of this room without opening a door or window as it would be for you to lift the Duodim over a pencil mark. Of course, there are no such creatures, but the possibility of our being able to accomplish similar miracles by means of mechanical contrivances is entirely feasible.

"Let us return to Flatland, where all objects have but two dimensions. Theoretically, we can easily conceive of such objects, yet in actuality no such things could possibly exist."

"Pardon me, Professor," I interrupted, "but I think I can give you an example of a familiar object which has only two dimensions. I remember hearing a radio lecture given by a famous editor and scientific writer, who likened a two dimensional object to a shadow. Obviously, a shadow has length and width but no thickness."

"That's a good illustration," Professor Banning rejoined, "but I think your scientific lecturer would not have used the term 'shadow' but rather 'projection of a shadow.' The word 'shadow' applies to all the space from which the light is cut off by a given object, and though intangible, it certainly has three dimensions. I'm glad you gave me that analogy, however, because it illustrates admirably the point I want to make.

"Let us consider the shadow cast by a silver dollar. Suppose the beams of light are parallel to each other and are perpendicular to the dollar and to a perfectly flat wall on which the shadow is cast. The projection of the shadow on the wall will be a circle and will have only two dimensions, but the shadow itself will be cylindrical in shape, with the surface of the dollar as one base, the projection on the wall as the other base, and with an altitude equal to the distance from the dollar to the wall.

"If you place a piece of flat cardboard, parallel to the dollar, anywhere between it and the wall, a two dimensional circular projection will be cast on the card. This shows that the three dimensional, cylindrical shadow is really made up of an infinite number of circular projections, no one of which has any appreciable thickness.

"But a shadow could hardly be considered as a material object, although Peter Pan was supposed to have lost his shadow. Then there was the other Peter—Peter Schlemiel, of the German story book, who sold his shadow to the Devil. In this charming fable, his satanic majesty is pictured as rolling Peter's shadow up like a blanket and carrying it off under his arm. All this, of course, is pure fantasy.

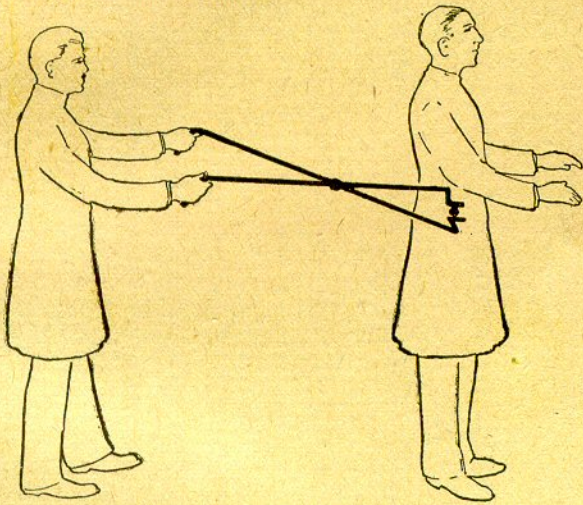
"In order for your Flatlander to have real existence, he must be made up of particles of matter, and that in itself makes *some* thickness necessary, even if he be only one-millionth as thick as the finest gold leaf—which is about the thinnest tangible object we know of. Compared to its length and width, this minute thickness would be practically equal to zero.

Yet we can conceive of piling on top of each other a sufficiently large number of such objects to build up a thickness that can be seen and measured—just as we can conceive of a three dimensional shadow as being made up of an infinite number of two dimensional projections.

"Now, let us assume that there are three of these Flatlanders who are developed enough mentally so that they can *think* in a third dimension and can imagine the possibility of motion in a third dimension. Duodim number one, a mathematician, draws a picture of a three dimensional object, such as a cylinder, just as any artist can draw on a perfectly flat piece of paper a picture that looks exactly like a solid object.

"Suppose Duodim number two—a mechanical expert, using this picture as a basis, cuts a large number of circles out of some material—which of course would have to be very thin—and places these circles one on top of the other until he has actually made a cylinder. It would be but a step farther for him to construct two rods, fasten them together in the form of a pair of tongs and bend them in such a way that Duodim number three—who is skillful in the use of instruments—can pick up something in the same plane a short distance away.

"Perhaps a diagram will make my meaning clearer." He picked up a pencil and a piece of paper from the kitchen table I used as a desk and rapidly drew a sketch like this:



"Pardon me," I interposed, "but I'm afraid there is a serious fallacy in your theory. In order to lift another object with a contrivance like that, your Flatlander would be obliged to move through the third dimension himself, and, according to the original premises, this would be impossible."

"Quite true," the professor concurred. "My sketch was not intended to be a practical working drawing, but merely a means of illustrating an idea. However, it ought to be easy for you, with your knowledge of mechanics, to design an instrument by means of which motion in one plane can be converted into motion at right angles to that plane. Isn't that possible?"

I had to admit that it was.

"Very well. All we need to do is construct such a contrivance having extension in the fourth dimension and Doctor Mayer will be able to remove my gall-stones without the slightest pain or shock to my system."

"But how am I going to know what a four dimensional forceps or tongs looks like?"

"Leave that to me. Just as the Flatland mathematician can draw a picture on a flat surface, showing what a three dimensional object looks like, I, by using three dimensional units, can construct models which will visualize to you the appearance and characteristics of a four dimensional object. This may sound complicated, but it really is quite simple. I can take any child ten years old of ordinary intelligence and, by means of a brief explanation and a few questions, I can get him to work out the attributes of a tesseract or four dimensional cube. Let me illustrate."

He picked up the pencil again and jotted down these headings:

	Number in Initial Cube	Number Generated by Motion	Number in Final Cube	Number in Tesser- act
POINTS (Corners)
LINES (Edges)
FACES (Squares)
SOLIDS (Cubes)

"Of course you understand how a tesseract is generated. You first move a point, or a corner—if you prefer that nomenclature—a unit distance, say one centimeter. This generates a line or edge one centimeter long. Next, you move the line for a distance of one centimeter at right angles to itself, thus forming a square with an area of one square centimeter. The next step is to move the square one centimeter at right angles to both its width and length, which will form a cube, one centimeter long, one centimeter wide and one centimeter high. Now, it only remains to move the cube for a distance of one centimeter in a direction which is at right angles to its length, width and thickness but is not parallel to either of its three dimensions and we have a unit tesseract.

"Let's see what this hyper-cube will look like. First we know that the cube we start with has how many corners?"

"Eight," I answered after a moment's thought.

He jotted this down in the diagram. "And how many edges?"

"Twelve."

This also he wrote on the slip of paper. "And how many faces?"

"Six."

"And of course there's just one cube."

"Now, when we move a corner, no other corners are generated; but at the end of the operation we have a second cube with eight corners, so the total number of corners in our tesseract will be how many?"

"Sixteen," said I.

"Correct. And each corner as it moves through space will generate what?"

"A line."

"And there are how many corners in the original cube?"

"Eight."

"Therefore, eight lines or edges will be generated by the motion. If we add the twelve edges in the original cube and the twelve more in the cube at the end of the movement, we will have how many?"

"Thirty-two."

"Thirty-two edges," he repeated.

"Now for the faces. We started with six square

faces in the original cube and there would be six more in the final cube. Would there be any more?"

"Certainly. Each edge would generate a square. There are twelve edges in the cube, so there would be twelve new squares generated. Six and six and twelve makes a total of twenty-four faces in the tesseract. Am I right?"

"Very good, indeed. You seem to grasp the idea admirably. Now see if you can tell me how many cubes there will be in the tesseract."

"Let me see. You have one cube to start with and one more at the end of the motion. Each square generates a cube. There are six faces in the cube. Six and two makes eight cubes in the tesseract."

"Correct!" said the mathematician as he jotted down the last figure and handed me the diagram. It read like this:

	Number in Initial Cube	Number Generated by Motion	Number in Final Cube	Number in Tesser- act
POINTS (Corners)	8	0	8	16
LINES (Edges)	12	8	12	32
FACES (Squares)	6	12	6	24
SOLIDS (Cubes)	1	6	1	8

"You see how simple it is. All we need to do is construct an object bounded by eight cubes, twenty-four square faces, thirty-two edges and sixteen corners and we have a four dimensional cube or tesseract."

"Since any object can be divided into a number of parts, each of which is a geometric solid of some description, and since I can work out the characteristics of the four dimensional counterpart of any geometrical solid, it ought not to be difficult to construct any kind of object in such a way that it will have extension in four dimensions. Don't you think that's reasonable?"

"It certainly sounds reasonable to me."

"And you will help us carry out these ideas in a practical way?" inquired Doctor Mayer.

I hesitated.

This seemed to surprise them. My enthusiasm had evidently led them to expect my immediate consent. After a moment of deliberation, I said, "I'm sorry to disappoint you, and I can't tell you how much I appreciate the compliment you have paid me; but I'm afraid I shall not be able to help you."

"Is it a question of finance?" Doctor Mayer wanted to know. "If so, you may rest assured that there will be plenty of money, both for whatever you need in the way of equipment and materials and also for your own remuneration."

"I wasn't thinking of money," I hastened to assure him. "There's no one dependent on me and my chief ambition is to serve humanity as well as my meager ability will permit. Otherwise, I am satisfied with a bare living. I happen to be broke and loafing right now; and, to be frank with you, I'm desperately in need of work. But—"

"Then why in the world won't you work for us?" Professor Banning interrupted.

"For the same reason that a man who has narrowly escaped drowning avoids skating on thin ice."

"Surely, you don't think there is anything to be afraid of!" This from the Doctor.

"Well, Sidelburg didn't think there was anything to be afraid of—and look what happened to him."

I'm not superstitious exactly, but sometimes I think that Nature resents our efforts to pry into her secrets—and punishes those who are too rash and impudent in wresting knowledge from her."

"Nonsense!" the Professor scoffed. "If that were so, Thomas A. Edison, Orville Wright, Robert Milliken and hundreds of other great men would have been destroyed long ago. Sidelburg was merely the victim of an unforeseen accident. He had just as good a chance of being struck by lightning or swallowed by an earthquake as of being destroyed by the Four Dimensional Roller Press."

"I read in the paper the other day about an elderly lady who was trampled to death by a trained elephant which became frightened while being led through the streets to a theater where it was to perform in a vaudeville act. I suppose that poor old lady has repeatedly worried about getting cancer or tuberculosis or being run over by an automobile, but I don't imagine she ever worried a minute about being trampled by an elephant."

Doctor Mayer took up the argument. "You said a moment ago that your chief ambition is to serve humanity. If you really meant that, here's your opportunity. Just think of the suffering that can be relieved when four dimensional surgery becomes a reality. Think of the lives that will be spared and prolonged—the grief and pain that will be assuaged—the added happiness that will be made possible. Suppose there is some danger. You say there's no one dependent on you. Aren't you man enough to take some risk to accomplish this great humanitarian purpose?"

Of course I gave in and consented to lend my aid to the enterprise. What else could I do? That very day I packed my meager belongings and, accompanied by Doctor Mayer and Professor Banning, boarded the west bound express.

Winchester had been selected as the place to carry on our work—for very logical reasons. To me, one place was as good as another. Professor Banning was equally indifferent to geographical location. I learned that he had just embarked on his sabbatical year and had planned to devote the entire vacation period to the development of four dimensional surgery.

Doctor Mayer, on the other hand, was still carrying a heavy load of responsibility in connection with his clinic. While it was not necessary for him to devote any appreciable amount of time to the work of producing the first four dimensional forceps, it was thought best for us to be near him, in case we wished to consult him on the medical aspects of the undertaking.

A portion of the hospital ground had been set aside for our use and a contractor had been engaged to erect a small building. Professor Banning and I together drew up the plans and supervised the construction work. While the structure was being built I gave most of my attention to ordering materials, machinery and other equipment.

As I look back now to the months I spent working shoulder to shoulder with one of the greatest scholars that ever lived, I begin to realize that the best education a person can get is that acquired from intimate association with people of superior intellect.

Professor Banning was the most charming and interesting of companions. As we worked together at tasks that frequently were purely mechanical in

character, we talked about a variety of subjects as far away from mathematics or mechanics as Tacoma is from Timbuctoo. There was scarcely a topic with which Professor Banning was not thoroughly conversant. His remarks revealed not only a surprising mass of information but an authoritative grasp of fundamentals as well. He was equally at home in discussing literature, architecture, music, philosophy, anthropology, philology, physics, advertising, law and theology. I listened to him with open ears, absorbing wisdom as a sponge sucks up water.

One day I started something by introducing the subject of spiritualism.

"Did you notice the article entitled 'The Denizens of Hyper-Space' in this month's issue of *Science and Psychology*?" I inquired.

"No, I haven't seen that yet. Who wrote it?"

"Doctor Hermann Gesellschaft."

"From Heidelberg, isn't he?"

"I shouldn't wonder."

"Well, what did he have to say?"

"I'm not sure I got it all clearly in my mind; but, so far as I could make out, he tried to explain certain psychic phenomena by the hypothesis that spirits are able to move through the fourth dimension. Among other things, he quoted a Professor Zoellner of Leipzig, who claimed that he had held a rope by both ends and had seen a square knot tie itself in the rope before his very eyes. He accounted for this seeming miracle by attributing it to spirits operating in the fourth dimension."

Professor Banning vociferated: "Zoellner was a fool and a dupe. Like some other pseudo-scientists I could mention, he permitted himself to be hoodwinked by mountebanks who posed as spirit mediums."

It was the first time I had seen the professor forget his usual tranquillity and kindly manner of speech. Perhaps it was his mathematical training that made him so intolerant of the idea that anything could exist outside the world of purely material things.

I made the mistake of persisting too long on the subject. "To me, the explanations of Gesellschaft and Zoellner sounded quite plausible. With so many marvelous discoveries being made every day, how can we say that the existence of spirits—or anything else, for that matter—is impossible? As Polonius said to his son, 'There are more queer things in heaven and hell than were ever dreamed of in your philosophy!'"

This provoked a snort of disgust from the professor. "Young man, your quotation is as addled as your reasoning appears to be. It was not Polonius but Hamlet that spoke those lines, and he said nothing about hell. The correct quotation is: 'There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy.'"

I didn't need to look up this passage to be certain that he was right. He always was right.

The professor stamped out of the workshop, leaving me very much squelched and cogently conscious of how superficial was my own paltry stock of knowledge when compared with that of a real scholar like Banning.

TEN minutes later he was back at my side, as affable and agreeable as if nothing had happened. As a result of our assiduous efforts, the four

dimensional forceps was gradually taking shape. If you will bear in mind that—just as a three dimensional solid is bounded by two dimensional surfaces—a four dimensional object must be bounded by solids—you will get an idea of what the Hyper-Forceps looked like. For instance, the parts that would ordinarily be cylindrical in shape were made up of thousands of small spheres grouped together like an elongated bunch of tiny grapes. You must remember, however, that these spheres cannot be placed next to each other, behind each other, or on top of each other. One authority calls the fourth dimension "*Through*," suggesting that the parts are placed *Through* each other. This relationship in the position of the parts that make up a four dimensional object is one of the hardest things for the human brain to grasp. I must confess that, without the aid of Professor Banning's models and formulas I should never have been able to construct the Hyper-Forceps.

The mention of formulas brings to my mind a somewhat amusing incident which occurred when we were approaching the fulfillment of our task. One morning Professor Banning came into the workshop with a common wooden bucket tilted at a rakish angle on his venerable head. He looked so comical that it was with the greatest difficulty that I suppressed an inclination to giggle. But the high respect which I had always felt toward him forced me to keep my face straight. I fancied I saw him casting surreptitious glances in my direction, as if he were trying to catch me grinning, but not a flicker of a smile did I dare venture.

Finally he spoke. "I suppose you want to know why I'm wearing this bucket. Maybe you think I'm crazy; but 'if this be madness, there's method in't' as our mutual inspiration, the Bard of Avon, puts it.

"The hardest thing I have to encounter in working out the formulas for these hecatonicosiahedragons and other polyhedragons is that I have to carry so many figures and symbols in my head. That, in itself, would be easy enough if it were not for the other figures and symbols which do not belong and which come into my head from *outside*,—thus mixing up my formulas. I recently discovered that these extraneous figures cannot penetrate wood. So all I have to do is keep this bucket over my head and the figures outside cannot get in."

"One of these days I'll have to borrow your bucket," I jested. "Not to keep the outside figures from coming in, however. For, when I finally manage to get one of your formulas *inside* my noodle, I feel as if I need a bucket or something thicker,—to prevent the symbols that are *inside* from getting *out*. But if, as you say, the figures can't get through wood, perhaps I'm already protected."

This seemed to tickle the Professor. He was even constrained to pay me a compliment—something extremely rare for him. He put his hand on my shoulder and said, "My boy, there's nothing radically wrong with your head. At any rate, it isn't swelled, and that's something."

"I don't see how anyone could get swell-headed over his thinking capacity when he's working with a real thinker like you," I came back at him.

"Thanks, my boy; but I'm afraid my mind isn't working so well today. This old carcass is pretty well worn out. Those pains have been bothering me again. I think I'll knock off for today. Can you get along without me?"

I told him that, so far as his part was concerned, the Hyper-Forceps was practically finished. It only lacked certain finishing touches which were purely mechanical in character and which I felt certain I could work out alone.

From that day, Professor Banning failed rapidly in health. It was as if the excitement of striving for achievement, which, like a powerful electric current had kept him going through months of gruelling strain, was suddenly snapped off—leaving only his feeble old body to fight the ravages of age and disease.

Realizing the necessity for speed, I worked with merciless haste, carrying my labors far into the morning hours and grudgingly taking but an hour or two each day for sleep and a bite of food.

At last the Hyper-Forceps was finished. In general outlines it was not unlike an ordinary medical forceps, except that it had a rough appearance, due to the thousands of small solids with which it was bounded. For instance, the portions that one would expect to be cylindrical in shape were made up of the small spheres which I have previously described, and their surfaces resembled those of a raspberry.

The really distinctive feature of the Hyper-Forceps was that it had four finger-holes or handles like those of a pair of scissors. There was only one pair of jaws, however, and they could be operated by either set of handles, working independently or in unison. When the two sets of handles were kept together, the device worked exactly like an ordinary three dimensional forceps. But when the right hand pair of handles was separated from the left hand pair, it operated a unique mechanism by means of which the jaws were made to move at right angles to each of the three dimensions of ordinary space—in other words, through the fourth dimension. This had been all figured out theoretically with such painstaking care that I felt absolutely certain it would work—though I, myself, during all my work and experimentation, had never attempted the crucial test.

It had been agreed between us that Doctor Mayer was to be the first one to operate the Hyper-Forceps through the fourth dimension, and I was perfectly content to concede that honor to him. Though it was as strong and rigid as a similar article occupying only three dimensions, I handled the Hyper-Forceps as carefully as if it were a beaker of thin glass filled to the brim with nitro-glycerine.

I took it immediately to Professor Banning's room and told the nurse to notify Doctor Mayer that the four dimensional forceps was finished. He had just completed an important operation and he still wore his surgeon's cap and frock when he entered the professor's room.

It was decided to put the Hyper-Forceps to the test right then and there. An inanimate object was selected for the first trial. Doctor Mayer picked up a medicine bottle from the table by the bed, drew out the cork and poured the contents into the wash basin. He then took from his pocket a lead pencil, jerked off the small rubber eraser, dropped it into the bottle and replaced the stopper.

"I shall attempt to take that rubber from inside the bottle without removing the cork," he explained. He placed the bottle on the table and reached for the Hyper-Forceps, which I handed him. Inserting the tips of his right thumb and forefinger in one

pair of handles, and those of his left hand in the other pair, he slowly manipulated the unique mechanism which we had devised for converting motion in three dimensional space into a corresponding movement at right angles to each of the three dimensions.

PREPARED as I was for something preposterous to happen, I was dumfounded to see the Hyper-Forceps, part by part, melt into nothingness and disappear from sight until only the handles were visible.

Guiding the instrument entirely by guess work, the Doctor moved it until he estimated that the invisible jaws ought to be somewhere inside the bottle. Then he brought the two sets of handles together. As if by some weird magic the jaws of the forceps became visible within the bottle, but they seemed to be suspended in space, with no apparent connection between them and the handles. It was a simple matter to work the handles until the jaws grasped the eraser. By separating the two sets of handles again, the Doctor caused the rubber to disappear completely, after which he pulled the handles away from the bottle and once more brought the handles together. Within a few seconds, the eraser had been lifted right through the solid walls of the bottle and had been dropped on the table!

"It works! It works! It works!" the Professor kept repeating in a shrill tone of voice. He arose and started jumping up and down on the bed, cutting a very grotesque figure in his outing flannel night shirt.

Doctor Mayer, too, was abnormally excited. He clapped his hands together and cried, "Oh boy!" like a kid who has just received his first air rifle.

It was not until afterward that I gave any thought to the incongruity of their behavior in comparison with my own. I, a callow youth, forty years younger than the Professor and fully twenty-five years younger than the Doctor was as cool and calm as an Eskimo, while these two dignified and mature men were cavorting around like a couple of first-graders.

"Can't you operate on me right away?" was the Professor's first thought.

"Why? Are you in very great pain?"

"No. In fact, the pain seems to have left me. But I just can't wait for you to try out the Hyper-Forceps on me."

"Unless it's a matter of life and death, I'd rather put it through some more tests, and incidentally get more practice in using it before I attempt to operate on you," was the Doctor's sensible suggestion. "The next thing I'd like to try is removing some object I can't see, like the inside of a nut."

"Would a peanut do?" I asked. Perhaps I ought to explain that I have a weakness for "goobers" and I had a few in my pocket, left over from a bag I had purchased that noon.

"Just the thing!" exclaimed the Doctor, as I handed one of the nuts to him.

Again the Hyper-Forceps was brought into play. It took a little longer to accomplish the purpose this time, as it was necessary for Doctor Mayer to grope around until he felt the kernel within the grip of the jaws. But he finally got hold of each of the two kernels in turn and dropped them on the table.

Like "doubting Thomas" of the Scriptures, I wasn't quite satisfied until I had made a personal investigation, lifted the shell, still perfectly intact, and shook it near my ear. Not a ghost of a rattle could I hear,

and the lightness of the nut was further proof that the amazing feat of removing the kernels without breaking the shell had been accomplished.

"Now for a trial on a living creature," cried the Doctor. "Let's go to my private laboratory. I think I have a good subject to experiment on."

Professor Banning donned his bathrobe and slippers, and the three of us went to the laboratory. Doctor Mayer's "subject" turned out to be "Wilhelm," a Toggenberg goat, which he had procured as a subject for some medical experiments.

"Here's an opportunity to see whether the popular jokes about the alleged cosmopolitan character of a goat's diet are founded on fact," he jested. "This time, I think I'll use my X-ray goggles. You know about them, of course?"

We both shook our heads.

"There's not much to them. Same principle as fluorescent screens, but made in the form of goggles for convenience. I use them in connection with this specially designed operating table. You see, it has a Roentgen tube arranged in such a way that it throws the X-rays right through the body of anyone lying on the table."

He lifted Wilhelm to the table and strapped him fast. Then he threw the switch that operated the X-ray apparatus and adjusted the goggles to his eyes. In order that we might get the full benefit of the experiment, he provided each of us with fluorescent goggles.

That the goat had some foreign substances in its stomach was instantly apparent. Doctor Mayer picked up the Hyper-Forceps and worked the handles. Again the instrument, except for the handles, faded from sight. This time, Doctor Mayer seemed to have considerable difficulty in placing the jaws where he wanted them.

"Odd!" he exclaimed. "Most peculiar feeling. Like pushing something against some yielding substance or against a strong current of air or water. See, in this direction it moves easily; but I have to use all my strength to make it move in the opposite direction." So absorbed were we in the experiment itself that we made no attempt to explain this remarkable phenomenon just at that time.

By exercising the utmost care, accompanied by the expenditure of considerable elbow grease, the Doctor finally succeeded in forcing the Hyper-Forceps into the position he desired. Then he brought the two sets of handles together, making the jaws of the forceps appear inside the goat's stomach. Then, one by one, he removed the following objects: An iron bolt, three shingle nails, a tire valve cap, a boy's marble and two safety pins. Through it all, Wilhelm kept up an incessant, "Ma-a-ah! Ma-a-ah! Ma-a-ah!" but did not seem in the least bit distressed during the moments when the four dimensional forceps was exploring his internal workings.

"Well, that ought to be proof enough that it works," Professor Banning remarked. "The only thing that remains now is to try it on my gall-stones. I move that we do it *right now!*"

Doctor Mayer seemed equally anxious to make the final test. "All right," he assented, "but first let me send for my brother. Though I don't expect any complications it may be best to have another surgeon present."

Doctor Julius Mayer responded promptly. He had, of course, heard all about the four dimensional

forceps from his brother, and it took but a few moments to explain the device to him.

"It won't be necessary to make any special preparations, will it?" asked the patient.

"I don't see the need of it, except that I shall of course sterilize the Hyper-Forceps. You might get a can of ether handy, Julius, to use in case something unforeseen happens. But, judging from the way that goat behaved, I'm sure we won't have to use it."

CLAD just as he was, in nightgown and bathrobe, Professor Banning stretched himself out on the operating table. Doctor Paul Mayer turned on the X-ray and adjusted the fluorescent goggles.

As he started to manipulate the Hyper-Forceps, he again remarked about the difficulty he experienced in forcing it to move in certain directions and the ease with which it moved in other directions. However, he finally succeeded in introducing the jaws of the forceps into the patient's body, where we could plainly see them with the aid of our X-ray goggles. After several trials, he placed the jaws of the instrument inside the gall bladder, where the offending gall stones could be dimly discerned. All this time, the Professor was fully conscious of what was going on.

"Feel any pain?" the surgeon asked.

"Not a bit."

"Any unusual or peculiar sensation?"

"Not yet. Ouch! I did that time! It didn't hurt very much, though."

"I just pinched your liver a trifle," the Doctor explained.

Just then, a horrifying thing happened. The inside of Professor Banning's body, made faintly visible by means of the X-ray, seemed suddenly to melt away. A few seconds later his ribs faded from view. At the same instant, Doctor Paul Mayer gave utterance to an agonizing cry, "My God! There's something pulling against me!"

I jerked off the goggles and dashed to his side, exclaiming, "Can't I help you?"

"No. Better keep away! Good heavens! Look at my arms!"

My blood almost congealed at the unspeakable sight! His arms seemed cut off at the elbows! His forearms and hands had disappeared completely, and so had the handles of the Hyper-Forceps!

I took another horrified glance at Professor Banning's body just in time to see it fade completely from view!

By this time, all of Doctor Mayer's arms and part of his chest had "melted" from sight. His brother rushed to him and grasped him around the waist as if to draw him back to safety. He might as well have tried to hold a wisp of smoke. The last words we heard from Paul Mayer were, "For God's sake, let me go!" With a moan of despair, his brother released his hold. A moment later, not a vestige of either Doctor Paul Mayer, Professor Banning or the Hyper-Forceps remained.

Julius Mayer and I stood looking at each other, both of us transfixed with horror. In his face, I saw reflected all those emotions and sensations which were racking my own body and brain:—grief, perplexity, awe, and—overshadowing all else—a ghastly consciousness of stark fear.

He was the first to speak: "My God, what shall we do now!"

"Perhaps we'd better notify the police," I stammered.

"Good Heavens! Don't do that! Not yet, at least. Let us first be sure we've done all we can ourselves. You know more about this wretched four dimensional business than I do. Can't you suggest something?"

"Possibly they are still in this room, but have merely been made invisible," was the only suggestion I could think of.

Acting on this hypothesis, we groped about the room, exploring every portion of it with our hands and arms. We even placed a stool on top of a wheeled stretcher, such as are used for carrying patients to and from the operating room, and I stood on it and thoroughly probed the space for several feet below the ceiling, while Mayer wheeled me about the room.

I might have known how useless this procedure was, since a person who has moved far enough into the fourth dimension to be out of sight would of course be out of reach as well. However, anything was better than doing nothing in the face of such a dreadful and critical situation. At the end of an hour, we had to admit our helplessness. We could understand the feelings of a naval officer who knows that many fathoms beneath the keel of his ship there are thirty gallant men slowly dying horrible deaths in the belly of a disabled submarine and yet is utterly powerless to do anything to help them.

Hopeless in his despair, Julius Mayer finally said, "I suppose there is nothing to do now but notify the police. I'm afraid that we are going to have a hard time explaining how my brother and Professor Banning disappeared."

"Well, if I'm to be put through the third degree, I suppose I may as well change my clothes." I was still wearing the overalls and work shirt which was my customary apparel while laboring at my mechanical tasks.

Leaving Julius Mayer to take care of the formality of notifying the authorities, I went to the work shop, where my street clothes were hanging.

As I entered the room where Professor Banning and I had worked together for so many eventful weeks, I had a strangely weird feeling of dread—such as a superstitious person might experience on coming unexpectedly into a graveyard. I experienced a mysterious consciousness that there was somebody present who could not be seen or heard.

Then my attention was arrested by a most astounding phenomenon. A drop light, which had been installed to enable us to work at night, was behaving in an amazing manner. The cord was drawn to one side until it was almost horizontal, with the globe and shade apparently supported in space in utter defiance of the law of gravitation. My eye, searching for an explanation of this miracle, suddenly encountered something which I recognized instantly as the jaws of the Hyper-Forceps!

If I was scared before, I was thoroughly terror-stricken now. I could feel the goose flesh rising all over my body and my hair began to bristle, "like quills upon the fretful porcupine."

My first impulse was a cowardly one—undoubtedly prompted by the universal but sometimes dastardly instinct of self-preservation. I wanted to

run away—to call help—to let someone else take the risk of rescuing those two men whom I now knew to be hanging out there in hyper-space with nothing but two flimsy strands of electric wire holding them to earth.

Just what made me stay, I am not sure, but I think it must have been the genuine love with which I had learned to regard Professor Banning. In many ways he had treated me as a father would treat his son, and to me, who had never enjoyed the benefits of a parent's care, this had meant a great deal.

That quick action was imperative, and that there was no time to go for help, was immediately apparent. The cord was manifestly under a greater strain than it could be expected to bear very long, and I heard an ominous crack which told me that one of the screws holding the fixture to the ceiling had become loosened.

For one who never made any claims to strength or courage, it took a heap of nerve to do what I did. I could easily imagine just how Lindbergh felt when he stepped into the cockpit of the "Spirit of Saint Louis" and hopped off across the storm-tossed sea, not knowing whether he would ever come out alive. How was I to know what frightful fate might take possession of me the moment I grasped the jaws of the Hyper-Forceps? Would it be possible for me to draw these two men back to earth, or would my own body be sucked into eternity, just as the body of Doctor Mayer had been pulled away before my very eyes?

Whatever was to be the outcome, there seemed to be nothing else to do, so I leaped on the work bench, which was just high enough to enable me to reach the jaws of the Hyper-Forceps. I had presence of mind enough to brace myself by a tight grip with my left hand on the framework of a large machine drill before I reached with my other hand for the Hyper-Forceps.

Just as I grasped it, the last of the screws holding the light fixture gave way, and with a jerk that almost pulled my arm out of its socket, the entire strain was shifted to my body. I managed to hang on, however, and in a little while the stress was somewhat relieved. It felt like holding the string of a big kite in a strong wind—just a steady, powerful but yielding tug. I found that by exerting myself, I was able to pull against the force that was resisting me. Gradually, more and more of the Hyper-Forceps came into view until it was entirely visible. Though I had fully anticipated what was to happen next, it seemed almost too preposterous to believe when I perceived a detached human hand clinging to the handle of the Hyper-Forceps and apparently suspended in midair. As I slowly drew it toward me, first the right arm, then the torso and legs and finally the head of Doctor Mayer loomed into view. His left arm, except for a small part close to his shoulder, was still invisible, however.

By this time, Doctor Mayer was able to help himself by hooking one foot in a vise which was fastened to the bench, and with this extra bracing added to my tugging on the Hyper-Forceps, we quickly succeeded in drawing into the room the body of Professor Banning whom the doctor had been holding by the hand.

You can easily imagine the relief which they felt at being snatched from a horrible fate, and you can

also picture the joy with which I welcomed back these two travelers into the mystic realms of hyper-space.

Like a typical youngster, I plied Professor Banning with questions, which he undertook to answer somewhat as follows: "As nearly as I can figure out, the part of the Hyper-Forceps which extended into the fourth dimension must have been caught in some current of cosmic force which was strong enough to draw the entire instrument out of three dimensional space, pulling Doctor Mayer and myself with it.

"Naturally, it will take me some time to work out a truly scientific explanation, but there were certain indications which led me to believe that as soon as we disappeared from your sight we began to lose our gravitational attraction for the earth. I put it that way because, as you doubtless know, every object on the globe attracts the earth itself just as truly as the earth attracts it.

"Being projected into the fourth dimension had the effect of relieving us from some of the gravitational attraction of the earth, but our bodies still had momentum enough to carry us along with the earth. Of course we did not lose all our gravitational attraction for the earth, but only a portion of it. Had we lost all, we would have been shot out into space by centrifugal force, like rocks shot from a sling. Perhaps our position might be likened to that of a piece of iron which is moved from in front of a magnet to one side of it, so that the lines of force extended at a changed angle and with a diminished force.

"After a few moments we noticed that we seemed to be slowly drifting away from the place where we originally left three dimensional space. I account for this by the assumption that our momentum was being slightly decreased while the motion of the earth was continuing at the same rate of speed. Our bodies passed easily right through the walls of the hospital building. Though everything was plainly visible to us as we floated along, we found that all efforts to grasp or hold any three dimensional objects

were fruitless. They melted in our fingers like so much vapor. Our bodies also seemed almost transparent and I found that I could easily stick my hand right through my own chest without any discomfort. At the same time, I found that when I grasped Doctor Mayer's hand, in order to prevent us from being separated, I was able to hold it and to stay close to him without being able to feel any sensation of contact. With his other hand, Doctor Mayer still clung to the Hyper-Forceps. It was a good thing he did hang to it, because without its help we should never have been able to get back.

"In a little while we found ourselves floating through the workshop. I quickly realized that if we continued to drift in this manner we would soon be left hanging in space with the earth hurtling away from us at a terrific speed. It was then that I thought of using the Hyper-Forceps as a means of getting back. Acting on my instructions, Doctor Mayer grasped with the Hyper-Forceps the first object he could reach. It happened to be that light-cord. It was lucky you came in when you did, because it seemed impossible for us to pull ourselves back without help. Please bear in mind that this explanation is purely superficial and there may be some flaws in it which I shall have to correct later when I have had an opportunity to go more deeply into the scientific aspects of the subject. In general, however, I believe that the solution of the mystery is about as I have given it. Does that make everything clear, or would you care to ask any more questions?" This last sentence was a favorite of his which he invariably used in the class-room at the end of each lecture.

"There's just one more thing I'd like to know," I ventured. "What about your gall stones?"

"Oh, they are all gone, thank Heaven. While we were drifting around in hyper-space I could look right inside myself and I could see those pesky gall stones quite clearly. So I just reached inside myself and plucked them out with my fingers!"

THE END.

What Do You Know?

READERS of AMAZING STORIES have frequently commented upon the fact that there is more actual knowledge to be gained through reading its pages than from many a textbook. Moreover, most of the stories are written in a popular vein, making it possible for any one to grasp important facts.

The questions which we give below are all answered on the pages as listed at the end of the questions. Please see if you can answer the questions without looking for the answer, and see how well you check up on your general knowledge.

1. What two savage animals are to be found in the Allegheny Mountains? (See page 1030.)
2. What famous road is there in Japan which is said to be ideal for a motor vehicle race? (See page 1035.)
3. Where was the historic lake submarine built and what were its characteristic features? (See page 1042.)
4. Baron Münchhausen was a real person, whose name has been borrowed for special use in literature. What was his full name and title? When was he born and when did he die? (See page 1062.)
5. How could two grains of sand affect a one-dimensional being? (See page 1080.)
6. What is a Tesseract? Can you start from the conception of a point and develop a tesseract? (See page 1081.)
7. What is the general term for four-dimensional solids? (See page 1083.)
8. What constitutes the difference between atoms of different substances? (See page 1089.)
9. What is the relation between atomic weight and atomic number? (See page 1089.)
10. What are the three principle rays evolved by electrical excitation? (See page 1089.)
11. What are these rays? (See page 1089.)
12. Suppose one were able to remove electrons one by one from the atom of any particular element, how would it be affected? (See page 1090.)
13. What is an endothermic reaction? What is an exothermic reaction? (See page 1090.)
14. What is the analogy with the solar system in the arrangement of the constituents of an atom? (See page 1093.)
15. In the atom, what part suggests the sun and what part suggests planets revolving around the sun? (See page 1093.)