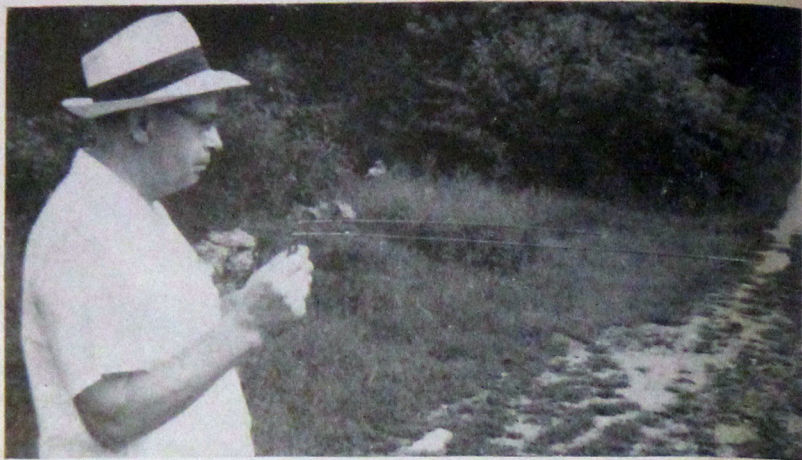


Engineer's Art

BY RANDALL GARRETT



To some people, a "fact" is something found in books; what happens in Nature is not a "fact," but a "phenomenon," and not really important. Herewith an account of what can best be described as "a well-documented run-around" when our reporter tried to get Yale University to discuss "a phenomenon"...



Harry C. Ritchie, of the Milford Water Works uses the dowsing rods for the usual reason an engineer uses a piece of equipment—because they work usefully, and save money and time in locating pipes.

■ The story may be apocryphal, but it has the ring of truth. It seems that a certain quaestor, some two thousand years back, was sent out from Rome on a routine job of checking the books of the various projects that were being financed by the City—the building of roads, aqueducts, and the like. He particularly wanted to look at the work of an aqueduct engineer, one Facio Facile—not because there was anything wrong with Facio's work, but, on the contrary, because there was so much right about it. Facio could build an aqueduct that was as good or better than those built by other engineers, and he managed to do it with less expenditure of money.

Upon reaching the spot where Facio was working, the quaestor was told that Facio himself might be

found atop the stonework, so the quaestor climbed up to see what the engineer was doing.

He came upon a strange sight. Facio, a big, burly man, built like a Thracian gladiator, was tossing chips of wood into the stream that ran along the top of the aqueduct and counting softly to himself.

He would drop in a piece of wood, and, as it was caught by the current, he would begin: "I, II, III, IV, V, VI, VII, . . ." Further downstream, an assistant eyed the water carefully, and, as the chip of wood passed a certain mark, he would call out, "*Desiste!*" "Stop!" Facio would mark down something on his tablet, toss in another chip, and begin counting again.

The quaestor hated to interrupt this interesting bit of magic—undoubted-

ly a spell of some kind to keep the water going—so he waited quietly until Facio noticed him.

Finally, when he had finished with his mysterious ritual, Facio came over to where the quaestor was standing, whereupon, with some small ceremony, the quaestor identified himself and produced his papers of commission, or whatever passed for such papers in those days. Then he said: "I say, Facio, that was an interesting spell you were using. Appolonian, isn't it?"

"Eh?" said Facio, looking blank.

"Er . . . Pythagorean, I meant, of course," said the quaestor, correcting himself hastily. "The numbers—"

"Oh, *that*," Facio gestured deprecatingly. "No, noble quaestor, I was just checking to see how fast the water is flowing."

It was the quaestor's turn to look blank. "How *fast*? Why, whatever for?"

"Well," said Facio, "the faster the water is moving, the less pressure there is against the sides of the duct, so you don't have to build the walls so thick. Saves stone."

"There's *less* pressure, the *faster* it goes?" The quaestor was not sure he had heard aright.

"That's right," said Facio Facile.

Now, this did not seem right to the quaestor. *Vir et puer*, he had had some thirty years of experience with rivers. He had swum them, waded across them, rowed boats across them, drunk out of them, and even fought in them, and he *knew* that the pressure was

greater in a fast-running stream than it was in a slow-running one. In a lake, where there was no current at all, a man could walk in up to his neck, but some of those fast-moving Alpine streams would bowl a man over before the water got to his knees. He said as much to Facio.

"I know, I know," said the engineer without concern. "It may not sound right, but that's the way it works."

"But *why*?"

Facio Facile shrugged. "I don't know why, noble quaestor. And I don't much care. All I know is, it works; and as long as it works, I use it."

The problem bothered the quaestor all the way back to Rome. It *still* didn't sound right. And yet, there was no doubt that Facio's principle worked; he had figures to prove it. Not abstract, abstruse figures, either, but nice solid, concrete figures, expressed as sesterces and denarii. Financial figures that even a senator could understand. By saving stone at the right places, Facio Facile was also saving time and labor, which meant that he was saving money.

Not only that, but Facio's aqueducts didn't spring leaks that called for costly repairs—another money-saver.

After making his report to his superiors—who didn't care how Facio was saving money, either, so long as he did it—the quaestor went to see the famous mathematician and philosopher, Mens Clausa, to whom he outlined what he had seen and heard.

Mens Clausa listened with polite skepticism; he, too, had had experience with rivers.

"Well, now," said Mens Clausa, "it sounds like magic to me, and mathematics can't be applied to magic, you know. And I don't believe in magic, anyhow, much."

"I thought maybe it was based on some scientific principle," said the quaestor.

Mens Clausa shook his head. "We have done a lot of work on the principles discovered by the great Archimedes and I assure you that the laws of hydrostatics do not account for any such phenomenon as you describe. No, I'm afraid I can't help you. Better go see a sorcerer, noble quaestor."

The quaestor did just that, but the sorcerer didn't know anything about that kind of spell, and suggested that the quaestor ask a priest. After discussing it with three or four Vestal Virgins and two lesser *pontifices*, who in turn referred him to someone higher up in the hierarchy, the quaestor finally spoke to the *pontifex maximus* himself.

"No," said the P.M., "that's not in my field. Has nothing to do with religion. Sounds like a lot of foolishness to me."

So the quaestor went home, troubled at heart because the wisest men of Rome knew nothing of the problem and had no wish to investigate it, while Facio Facile went quietly on with his work of building aqueducts.

As I said, the story is undoubtedly apocryphal, but it has the ring of truth.

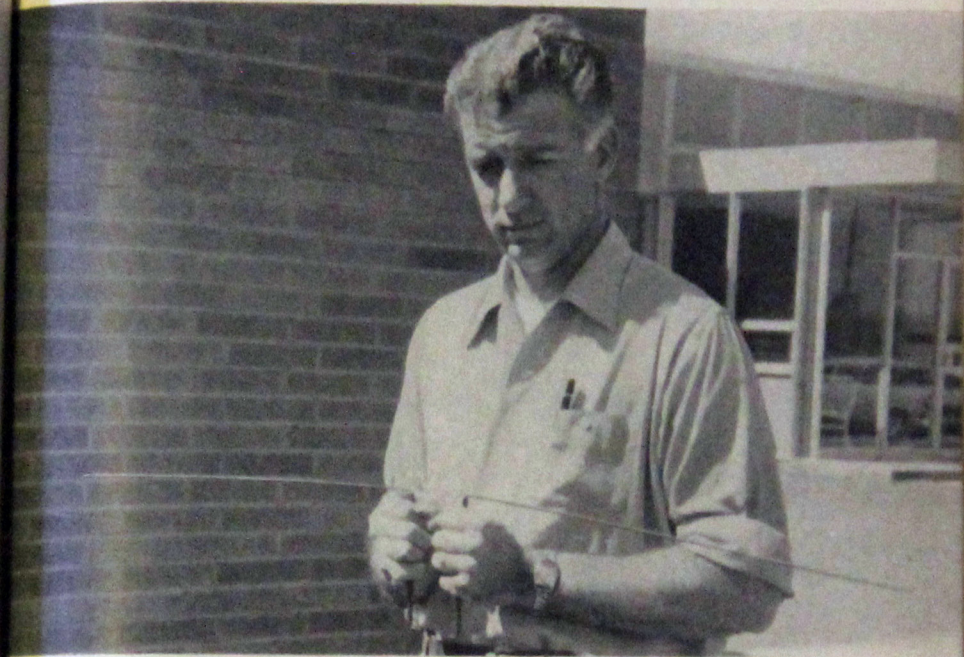
I know, because I, too, went on just such a quæst this past August.

A couple of years ago, in the October, 1958 issue of this magazine, John Campbell printed an article in which he described a most unusual gadget for locating pipes. It consists of two sections, built alike, one section being held in each hand. Each section consists of a thin steel rod bent in an L, with the shorter leg of the L—about five inches long—inserted loosely into a copper tube, which serves as a handle and allows the longer leg—about eighteen inches long—to swing freely when the copper handle is gripped.

Using them is equally simple. Take one of the sections in each hand and march across an area where you suspect a pipe is buried, and hold them so that the long legs are pointed out straight in front of you, "like a Western sheriff holding a couple of six-guns," to borrow Mr. Campbell's phrase. As you approach the buried pipe, the legs will begin to swing, either outward or inward. When you are directly over the pipe, the legs will be in line with each other.

Because of the simplicity of the device, many readers built a pair for themselves and tried them out, and letters came in from all over, voicing various theories as to their operation. Mr. Jim Harmon, a writer who lives in the Midwest, even built a pair out of coat-hanger wire and a couple of Coke bottles and had a certain measure of success with them.

W. F. Marklund, Distribution Supervisor of the Division of Water Supply, for the city of Flint, Michigan, was one of the pioneers in introducing the rods to utilities engineers in this country.



But the question of how they worked remained unanswered.

It was pointed out that the things are so sensitive that a slight tilt of the handles, when they are held, will make the pointers swing in the direction of the tilt. That's all very well and good, but it merely brings up another question, to wit: How does the operator know when he is over the pipe? I won't go into the explanations that were offered for *that*, except to say that they ranged all the

way from "subconscious extrasensory perception" to "cheating."

In order to dig up more information, I took a train to the city of Milford, Connecticut,* armed with a camera, a battery-powered tape recorder, and a whole slew of questions.

Milford, Connecticut, is a town of fifty-thousand, more or less, an hour and a half from New York by train and some nine miles from New

* Not to be confused with Milford, Pennsylvania, home of the annual Science Fiction Writers' Conference.

Haven, Connecticut, the home of Yale University.

The day before, I had made an appointment with Mr. Harry C. Ritchie, manager of the Milford Water Works, so he was ready for me when I showed up at his office at half past nine in the morning.

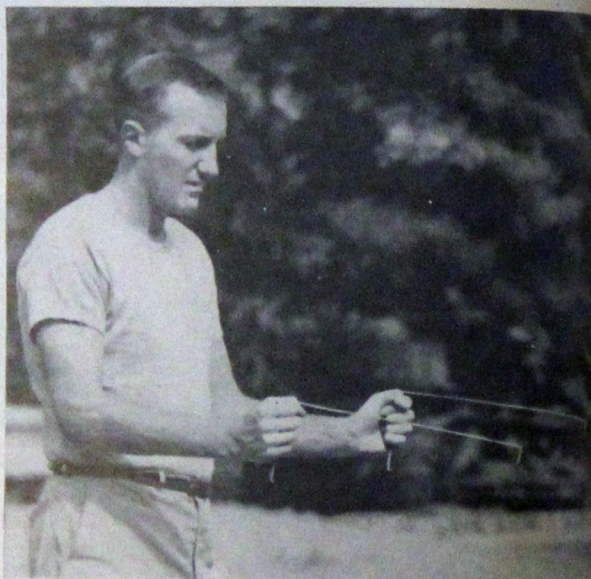
Harry Ritchie is a man in his early fifties, of medium height, with a

"Mr. Garrett wants us to show him how our pipe locators work," he explained. "Want to take a ride?"

"Sure," Herb Ahrens said.

Harry Ritchie opened a locker and got out the locators. They were a well-worn pair, looking as though they'd had as much use as any Western sheriff's forty-four had ever had. Then he put on his hat, and the three

*Construction workers
use the rods
before bulldozing
or running a
ditching machine
through—
they need to know
where pipes are
to avoid
tearing them out.*



shock of light-gray hair, a pleasant smile, a business like manner, and a soft voice that seems to have a touch of the South in it. He shook my hand warmly and led me through a busy outer office to his own office in the rear, where he introduced me to his assistant manager, Mr. Herbert Ahrens, a slim, quiet man in his thirties.

of us went out to Mr. Ritchie's car. He slid under the wheel, and Herb Ahrens sat next to him. I, burdened down with recorder and camera, got the back seat all to myself.

We headed down the main street of Milford, toward the edge of town.

"How long have you been the manager of the water company, Mr. Ritchie?" I asked.

"Twenty years," he said. "I've been with the company for thirty-two years."

"How long have you been using this type of pipe locator?"

"About fifteen years. Since right after the war. We've had very good results with them."

"Where do you get them?" I asked. "Do you buy them or make them?"

"We have them made. Years ago, we used to have a lot of difficulty locating pipes. I used to spend, sometimes, days, digging cross-ditches. The boys at New Haven had a set of these, and I borrowed them and tried them out, and they worked for me, so I had the New Haven Water Company build me a set of my own. I wouldn't be without them."

"Do they still use them in New Haven?"

"No," he said, "not any more. Mr. Carl Welton, head of the engineering department there, has had no luck with them. Some of his men could use them, but the rest didn't have any faith in them, and *he* didn't have any faith in them, so they gave them up as inaccurate."

I asked Herb Ahrens, who has been Ritchie's assistant for ten years, if he could use the locators.

"Yes," he said, "I've used them successfully many times."

We went over a bridge on the outskirts of Milford, and Harry Ritchie turned off the highway onto a road that was nothing more than a couple of worn tire ruts. It looked as though it might become a cow path a little farther on, then degenerate into a

squirrel track which would go up the side of a tree and disappear into a knothole. Still, for the first hundred feet or so, the tire-tracks looked well-used. I said as much to Harry Ritchie.

He grinned. "They're well used, all right. If it isn't the kids driving in here to neck, it's the State Police driving in to make sure they *don't* neck."

He stopped the car, and we climbed out.

Now, keep it in mind that this was a *demonstration*. It was *not* designed as an experiment. Neither Ritchie nor Ahrens—nor, for that matter, I—had the time to set up a rigidly scientific experiment that would exclude all possibilities of bias, error, foreknowledge, and the like. All I wanted was to see how they are used in the field, and that's what Mr. Ritchie was going to show me.

"There's a sixteen-inch main buried along in here somewhere," he said. "Let's see if we can find it." He picked up the two locators, aimed them, and started marching forward with slow, deliberate steps. "You've got to take it easy," he said, "otherwise you're liable to walk right over the pipe before they have a chance to swing."

The rods began to swing out. He took two more steps, and they were at right angles to their former position.

"You want to try it?" he asked, offering me the locators.

Me, I'm the reckless, foolhardy type. Throwing caution to the winds,

I got a firm grip on the two gizmos, backed off a little way, and started marching.

I decided not to aim for the same spot that Mr. Ritchie had aimed for; I aimed at a spot three or four yards to one side. I had no idea which way the pipe ran, except that it was at an angle to my line of march. If it were at right angles, that would have meant that Mr. Ritchie would be directly to my right when—and if!—the locators reacted. When I reached that point, nothing had happened.

"Keep going," said Mr. Ritchie.

I kept going.

Now, I'm willing to take an oath that I did nothing consciously to move those rods, but they began swinging outward at the next step, and, two steps farther on, they were parallel to my shoulders.

"Now let me show you something," said Mr. Ritchie.

He walked past me to some nearby bushes on my left, about four yards away, and pushed the foliage aside. "There's the service manhole," he said.

I was standing almost exactly on the center of a line drawn between the manhole and the spot where Ritchie had gotten his indication. As I said, this was a demonstration, not an experiment, but it was an impressive demonstration.

"Let's go up on the highway," said Mr. Ritchie. We left the car parked where it was, and walked back to the highway. This time Mr. Ahrens took the locators and walked across the pavement, as soon as there was a hole in the traffic. About three feet from

the far edge, the rods swung out again.

"That's the same sixteen-inch main," Ritchie explained. "I'll show you where it is a little farther up the road."

We walked up the highway to a crossroad, where Mr. Ritchie demonstrated the locators once more. I had noticed that the wind, which was rather gusty, had a tendency to wiggle the rods when I was using them, and had mentioned that fact to Herb Ahrens. As Ritchie approached the location of the pipe, Ahrens reached down, pulled up a few blades of grass, and let them fall in the wind just as the locators were swinging in his boss' hands. The wind was at Ritchie's back, and the rods were swinging *against* the wind!

Then Mr. Ritchie proceeded to show that it didn't take a hulking big sixteen-inch main to make those rods react. A six-inch pipe that led from the main to a fire hydrant several feet off the highway did the job as well.

"They'll pick up a one-inch service pipe to a house just as easily," Ritchie said.

We began walking back toward the car. "You say your men use these, too, Mr. Ritchie?" I said.

"That's right."

"All of them?"

"No. No; over the past fifteen years, I'd say about fifty per cent of the men can use them. But those fifty per cent can use them very accurately."

"A sort of all-or-none proposition?" I asked.

Ritchie nodded. "Either you can use them or you can't. They either work for you or they don't. If they don't work for you, they're useless; if they do, they're very accurate."

As we drove back to Milford, I asked Mr. Ahrens about his experiences with the locators.

"Well, I've seen them go wrong a few times," he told me, "but I'd say

"I think," he said, "that I'd have more faith in the electronic machine—that is, for accuracy within inches. But I've used these when the electronic machine has been out of commission, and I've picked up a main as deep as seven feet down with them. And within a foot or so of the actual location. When you go down seven feet, you have to be accurate."



Unlike electronic devices, the dowsing rods do not react to accidental buried scraps of metal—which makes them ideal for locating and avoiding buried pipes in a steel-mill yard construction project, or other metal-working shop yard.

that, for me, they're most successful about ninety per cent of the time."

For ten years, the Milford Water Works used nothing but these locators. Then, about five years ago, they bought an electronic locator. I asked Mr. Ahrens how the L-shaped locators compared with the electronic locator, as to accuracy.

"The advantage to these things," Ritchie put in, "is that there's no expense to them at all. You can make a pair for two dollars and a half. The electronic machine costs two hundred and seventy-five dollars, and the accuracy is about the same, in my estimation.

"Don't get me wrong," he contin-

*The suburbanite looking for the pipes
feeding and draining the swimming pool
can save a lot of lawn-damage*



ued, "the electronic pipe locator is a very good machine, and we put a lot of trust in it. We wouldn't be without it now."

"For a long-run layout," Ahrens said, "these things aren't too practical because it takes too long to center the pipe. You have to check it four or five times, back and forth across the street."

"That's right," Ritchie agreed. "With the electronic machine, you can follow the pipe directly. You can follow the main no matter how much it curves in the road, and you can mark out your trench as you go, so it's

more efficient. In that way, it is superior to these rods.

"But when the electronic machine is up for repairs," he said, "we still use these."

"For an outfit that doesn't have any means of locating a pipe," Ahrens said, "these are definitely a money saver and a time saver—not only to a utility company, but to a private digger who wants to be able to locate a pipe fairly accurately."

When we got back to Mr. Ritchie's office, I had a chance to go into further detail on the use and operation of the locator rods.



*And sometimes turns up a mystery.
A definite pipe reaction turned up . . .
but apparently it was an abandoned pipe line.
It didn't continue to any termination.*

"Do you have any idea how they work?" I asked.

"I haven't the least idea how they work," he said. "I think that it's magnetism, but that's all. I believe the rods are magnetized."

I thought that was odd, because, in handling the rods, I had noticed no tendency for them to attract or repel each other. "Do you mean they'll lift up a pin or a nail, the way a magnet does?" I asked.

"Oh, no; they're not magnetized in *that* sense of the word."

I could see what he meant. The rods *do* tend to behave as though there were some "magnetic" force making them line up with the pipe in the way that a compass needle lines up with the lines of force of Earth's

magnetic field—but, as Mr. Ritchie said, they're not magnetized in that sense of the word.

I asked him if he had ever done any experimenting with the locators—such as looking for a buried piece of wire or the like.

"I have, but I've had no luck with it. Too small, I think. That's where the electronic locator will throw you off. They're too sensitive. A lot of cinders have iron in them, and that doesn't attract the rods, whereas it *does* attract the electronic machine; the electronic machine will go wild. These won't. They won't work unless there's something definitely there."

"In other words," I said, "these only pick up what you're looking for, not the scrap and the junk."

"That's right. They won't pick up anything but pipe. Of course, you can pick up a cast-iron gas pipe as easily as you can a cast-iron water pipe. That's why I say it would be easier if you knew approximately the location of your water pipe. By 'approximate location,' I mean that you have to know there's a water pipe in the street

originally laid its location is marked out on maps, the distance being measured from nearby landmarks, such as a curb or a building. But buildings and curbs aren't permanent; they are torn down, and new structures are erected. Roads are straightened or widened or both. After a pipe has been underground a few years, the surface may



Almost anyone can use the rods successfully. A high school student.

—otherwise, you wouldn't be looking for it."

I asked Mr. Ahrens if he had ever done any experimenting with the locators.

"Every time you use it, it's an experiment," he said, "because every time you use it, there's a doubt."

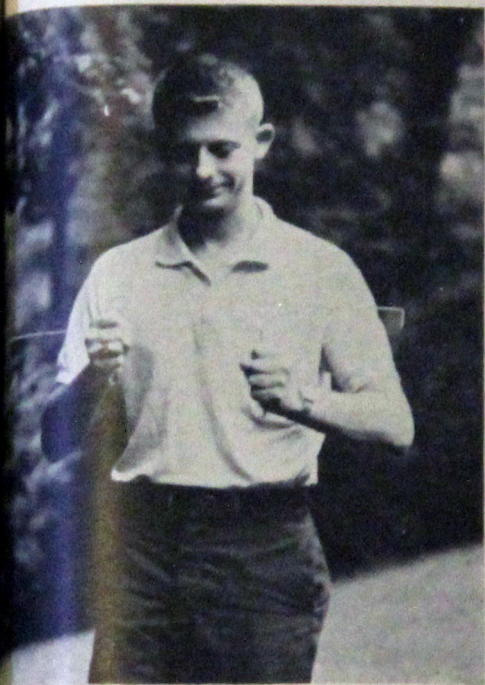
He explained that when a pipe is

be so changed that the reference marks are gone, and the map is useless.

"Under concrete or blacktop," he said, "if the road has been changed or resurfaced, you might think you know where the main is and be quite surprised when you go out there and find it's somewhere else.

"You can lay a pipe in a develop-

ment, say, today, and they can put in curbs tomorrow, and you've lost your markings from the day before. Pipe is supposed to be laid six feet from the edge, but if the surveyors change the line, or there's a difference of opinion about the line, the pipe could be under the sidewalk or in the middle of the road."



College student (accountancy major) . . .

"If you have to dig up a pipe running under a paved road," I said, "what kind of financial position are you in if you make a mistake?"

"Well," said Mr. Ritchie, "we have to dig till we find it, so we can't afford to make a mistake."

"Does it cost quite a bit of money to rip up a road?"

"Yes, it does. And we depend a great deal on these rods. If we dug into the wrong side of the road, that would be a lot of extra expense."

"Has that ever happened?" I asked.

"That has never happened," Ritchie said flatly. "We always come within two feet of the line."

Mr. Ritchie has never had any experience with nonmetallic pipes—Transite, clay, or concrete—since the Milford Water Works doesn't use any of those types. However, F. W. Marklund, of Flint, Michigan—another engineer who uses these locators—has success with nonmetallic pipes.

Herb Ahrens had already remarked that the locators only worked ninety per cent of the time for him, and he proceeded to amplify that statement: "I have found them, at times, undesirable when there is a lot of overhead electricity. But that is also true of the electronic machine; you'll have variations."

Both men agreed that the locators were not influenced one way or another by the dampness of the ground itself, nor by whether the pipe was full or empty.

By the time I left, I had, thanks to these two men, obtained a lot more firsthand information on the use of those locator rods than I had had when I started. But I wanted more. Surely a gadget like that, which has successfully been used commercially for fifteen years, would have attracted the attention of *somebody* who was both curious to find out how they worked and had enough scientific background to give them a good going-over.

The obvious place was Yale University, only a few miles away.

Sloane Physics Laboratory, where the administrative offices of the Physics Department are located, is a big, Gothic-looking building out on Prospect Street, about five blocks from the Old Campus. I found the office of the secretary of the department, and made inquiries.

give me a little of his valuable time.

Professor Robinson is a tall, well-built man with a handsome face, short-cropped dark hair, and a quiet, studious manner. He looks as though he would be a good basketball player, and, for all I know, he might be.

He asked me to sit down, and listened attentively while I explained what kind of information I was after.



*... Or art school major.
(In this experiment,
incidentally, the operator
was checking the
observation that,
when you want to find
the water main,
the rods do not react
to the obviously
present sewer main.)*

Pipe locators? Why, yes, they had a man who had done some work along those lines. One phone call later, and I was walking across a short open space to Gibbs Laboratories, a severely modern building, gray and glassy, looking like the UN Building laid on one edge. I went up one flight, and went to the office of Professor Hugh Robinson, who had consented to

I described the locators, told him how they were operated, what I had seen at Milford, and then popped my question: "Could you tell me how they work?"

He thought for a few seconds, then said, "Those would be the divining-type locators. There is supposedly no physical explanation for how they work, in the sense that physics, or sci-

ence, can tell you why they work. It's one of those weird things that people claim work, like telepathy or something like that."

"They're being used regularly down in Milford," I pointed out. "The manager of the Water Works there, Mr. Ritchie, has been using them successfully for fifteen years."

"It's possible to locate buried pipes electronically," Professor Robinson said, "but, if these are the ones I've read about, they're one of those so-called divining rods."

"Have you ever made any investigation of them?" I asked.

"No, I haven't. You can find these things written up in 'Fads and Fallacies in Science,' by Martin Gardner. He talks a good bit about this kind of thing. Some people use a forked twig.

"Now, if it were steel or cast-iron pipe, I can see how it might be picked up by a magnetized rod—if the pipe weren't too deep in the ground."

"Mr. Ritchie says his men have picked them up as deep as seven feet down," I told him.

He frowned a little. "I don't see how that could be done, even with a magnetized rod."

"You mean it would have to be buried shallowly, like the mines that were picked up by the mine detectors during the war?"

"Even that was an electronic detector," he said. "It sends out a signal, and you get a reflection of that signal by the conducting object. There is a type of detector for detecting non-

conducting materials, but it can only be done in homogeneous earth. The surroundings have to be homogeneous or it's liable to detect the nearest rock. But these types are not of this divining method, at all."

I said, "Do you know of anyone who is investigating this divining-type detector?"

"No one that I know of," he said. "Certainly nobody here is doing any work on them; we're more interested in basic research."

"Well," I said, "my point is that I've seen these things work, and I'd like to find someone who can tell me *how* they work."

"This looks like one of those weird things that you either believe or you don't believe," he said. "Gardner doesn't believe that they work."

"No. But Mr. Ritchie does. He's using them regularly."

"This technique," he said, "is probably something that we'd classify as nonscientific."

"You mean that it would be impossible to investigate it?" I asked.

"Well, we wouldn't investigate it here," he told me. "The people who would be interested in that would probably be the Psychology Department."

"The Psychology Department?"

"Yes. Once you determine that such things have a nonphysical basis of operation—if the operator is involved at all—then this would be up to the Psychology Department. If you couldn't use a mechanical man, if you couldn't use it on the Moon, say, with robots, if the operator is involved, the

Psychology Department would handle it. Duke University is doing a lot of this stuff. I don't know whether Dr. J. B. Rhine is working on this particular type of thing, but he's working on mental telepathy and such."

"It seems to me," I said, "that if this thing works on a commercial basis, if a man is actually saving money by using these locators, then it's worth investigation by *someone*."

"Well, two or three years ago, I saw a write-up of these. It was in one of these popular science magazines, or some such publication as that."

I had a strange feeling that I knew which magazine he was talking about, but I didn't interrupt him.

"According to the description, you can use coat-hanger wire or steel welding rods or brass welding rods or whatever you can get hold of, bend them like that, and put them in copper-tube holders. The author of the piece didn't make any claims; he just said, 'Try them out and see. They seem to work for us, maybe they'll work for you.'"

Did you ever try it?"

"No," he said, "I've never tried it."

"Do you know of anyone else in the department who might be interested in these things?" I asked.

"No. As I say, that would be for the Psychology Department." He paused, and then asked: "Did you look for things yourself with them?"

"Yes," I said, "they seem to work for me."

"Do you just pick them up and start using them?"

"Just pick them up and start walking across the ground," I said. "When you come to a pipe, they swing either in or out."

"I see." He looked thoughtful for a few seconds, then he said, "Well, the only type of detectors that we work with here are the electronic detectors, based on some basic, fundamental law of physics."

"If you haven't investigated these things," I said, "how do you know that their operation doesn't involve some basic, fundamental law of physics?"

"All the laws of physics that we have found so far," he said, "make a tremendous, complex structure based on a very few postulates. Any man, anywhere in the universe, we believe, can observe the same things we observe in our laboratories. He doesn't have to have a Coke bottle set on one edge of his desk and a drawer pulled open just so far, and things like that." He gestured, to indicate the Coke bottle on the edge of his own desk and the open drawer beneath it. "They are literally universal laws, and are completely independent of the operator."

"I had the impression," I said, "that Heisenberg's Uncertainty Principle says, in effect, that the operator is *necessarily* involved in an experiment."

"Well, the operator disturbs the system," he admitted. "But, statistically, we should all observe the same thing. It doesn't mean that you'll get different laws."

"These forces, the way things re-

act, and the way particles move—as far as we know, in all our experience, in everything we know about them—are independent of the operator. Except that he, himself, may have a magnetic field, or something like that.”

“Well,” I said, “if no one has investigated this at all, how do you know it is linked to the operator?”

“These things are supposedly well understood; these are not the areas in question at all now. If there is a pipe in the ground, one understands the fields and forces exerted on another piece of matter nearby. Given the two types of matter, one can predict this. And one knows how much force it takes to cause the deflection of such a device as you described, taking into account the friction of bearings and so forth.

“Then you simply examine the known forces in the thing, and determine whether they are enough to do the job. If there isn’t, you would probably conclude either that the thing doesn’t work, or that there is some mysterious effect caused by the operator, who tilts them in such a way that they swing out.

“The operator apparently knows, subconsciously, that the pipes are there, and swings them in some way or other. That’s the explanation that is often given.”

“Would you say, then, that it isn’t in the realm of physics to investigate this device, even if it does work?”

“Believe me,” he said, “I’d like to see one and see it used. To check it, you’d have to dig holes and bury things, and dig other holes and *not*

bury things, and make some sort of systematic check on it, which could certainly be done.

“But this type of problem is something that, usually, we’re not interested in as a matter of research.”

“And you have no idea who would be, except for the Psychology Department?”

“No. The reason I say the Psychology Department is that this appears to be something involving the operator. That would be my very strong guess, and it would have to be *proved* that it was *not* something involving the operator, first of all, before we could work on it.

“Certainly, if the thing works, it would be very nice to explain *why* it works—but I’m not convinced it works.”

“I remember an engineer,” I said, “who was convinced all through 1945 and through most of ’46 that the atomic bomb was pure propaganda, because ‘everybody knows you can’t influence the rate of atomic disintegration.’”

“Well, he just didn’t know enough,” said Professor Robinson.

“Yeah,” I said. “Exactly. It seems to me that there are some areas that *nobody* knows enough about.”

“Hm-m,” he said noncommittally.

We discussed electronic detectors for a few minutes more, then I thanked him for his time and information and asked him if he could recommend any particular person in the Psychology Department. He suggested that my best bet was to get in touch with the secretary. I thanked

him again and headed for the Psychology Department.

I don't know whether the Trustees of Yale had any conscious thought of intentional symbolism when they separated the buildings housing the Students of Matter from those housing the Students of the Mind, but it is a geographical fact that the Physics Department is situated near one extreme of the long Yale campus, while the Medical Center, where the Psychology Department is located, is eleven blocks away, at the other end. Only the Divinity School, just beyond the Physics Department, is farther away from the Psychology Department. I wasn't driving, and small town taxis have meters on them that turn very rapidly. Like South American politics, they require a tachometer to measure the RPM.

After a little telephoning, the girl at the information desk informed me that Dr. Claude Buxton, head of the department, was unavailable but that Dr. Allan R. Wagner would see me.

Dr. Wagner is fairly tall and lean and has his blond hair crew cut. He was wearing dark-rimmed glasses, Bermuda shorts, and an easy smile.

After I told him what I wanted, he made it clear that he did not want to be quoted on anything he said. In deference to his wishes, all I will give is the general impression I received.

There seems to be a generalized feeling in psychological circles that such things as these pipe locators are subconsciously manipulated by the

operator. The operator knows the terrain, and subconsciously responds to cues given to him by geographical configurations, the actions of other persons nearby who know the location of the buried pipe, and so on. Belief—faith, if you will—in the operation of the locators enables these subconscious impressions to come to the fore enough to cause a slight tipping out of the hands when the hints indicate he is over the right place.

Thus, they are similar in operation to the pendulum sex-detector, which consists of a small weight—an ounce or so—attached to the end of a five- or six-inch length of thread. The unattached end of the thread is held between thumb and forefinger, allowing the weight to swing freely. When this device is held over the hand or head of another person, the weight will swing back and forth in a straight line if the person is male, and will swing around in a circle if the person is female. It is also used to detect the sex of the author of a letter or the owner of a piece of clothing. Many psychologists believe that this, too, is the result of hints that register only on the subconscious—a whiff of perfume or pipe tobacco, say, would do the trick, even if the person holding the pendulum were blindfolded.

Many other psychologists won't even go that far. They tend to discount or minimize even the effect of such subconscious hints and point out that poor records are kept of the actual number of successes and failures; that, statistically, good records would

show that the number of successes are no greater than chance would allow, but, the human mind being what it is, the number of successes are exaggerated in importance, and the number of failures forgotten.

Dr. Wagner, like Professor Robinson, referred me to Martin Gardner's "Fads and Fallacies in Science."* (I had read the book, both in the original and in the revised edition.)

I got the impression that Dr. Wagner was of the school of thought that believes properly kept records would show that the detectors' success-to-failure ratio is no better than chance permits.

I asked Dr. Wagner if there was anyone else in the department who might be working on this or any related problem. So far as he knew, there was not. He even very kindly went to the trouble of asking several of his colleagues whether they knew of any such studies. None did.

The only work of that kind, apparently, was that being done at Duke by Dr. J. B. Rhine.

Dr. Wagner suggested that someone at the Physics Department might be able to tell me more about the physical forces involved than he could. I thanked him very much for

his information and time, and went back out to the sweltering streets of New Haven.

The ghost of that ancient Roman quaestor rose up beside me and suggested that I try the Divinity School next. I bade him begone, to return whence he came, and headed back to New York.

What had I learned? Well, in terms of direct information received, not much. I still did not and do not know what makes those locators work.

Magnetism? No. A field strong enough to cause those rods to move that way would be easily detectable. If the rods themselves were that magnetic, the tips would either repel or attract each other with a force that would be immediately apparent. If the pipes underground were that magnetic, there would be no need for locators of any kind; all you'd have to do would be to follow the line of beer cans, bottle caps, hairpins, paper clips, and other ferrous rubbish that would accumulate on the ground above them.

I had, of course, heard the "subconscious reaction to nearly imperceptible hints" theory before. I was well aware that many people dismiss the whole thing by saying that records, if kept, would show that there were far more failures than successes. I also know that even when records are kept and carefully tabulated, as they are in Dr. Rhine's experiments, many people will still dismiss the tabulations as erroneous or biased.

*It's remarkable that both the Physics and Psychology departments at Yale cited this frankly heavily biased, and inaccurate book—done by a non-Ph.D. at that!—as an authority on the subject. In most areas, professional scientists do not consider the meticulous *Encyclopedia Britannica* at all adequate as a reference, and certainly would not cite a nonscientist, Martin Gardner, in preference to widely-recognized professional scientists such as J. B. Rhine, Ph.D. and Professor H. J. Eysenck. The standards of what constitutes an "adequate authority" with respect to psi phenomena show an amazing shift from the standards applied in other areas. Ed.

I am not going to quarrel with any of the theories that have been cooked up to explain or explain away the operation of those detector rods. Nor will I advance any theory of my own.

Why? Because, as far as I have been able to discover, *not a single one of those theories has ever been subjected to any kind of experimental checking!*

This is what they call science? Heavens to Betsy!

Now please notice that I am not taking either Professor Robinson or Dr. Wagner to task for not personally having done any work in that field. As Dr. Isaac Asimov pointed out in his article, "The Sound of Panting," no scientist today can be expected to have read all the literature in his field, much less to have actually conducted laboratory experiments on every path and byway that comes along. But that's not the point.

The point is that both Robinson and Wagner—aye, and even Martin Gardner—have repeated theories that *no one* has bothered to check! I'm not trying to single these men out as the sole offenders; not by a long shot. Far from standing alone, they are apparently standing with the great majority of their colleagues.

Have there been no records kept? Well, I should say that the financial record of the Milford Water Works is a pretty good indication of the success-to-failure ratio. Look at it: Mr. Ritchie, for ten years, used these detectors exclusively, and he says that not once has he ever been more than two feet from the pipe he's been look-

ing for. Could he have "forgotten" his mistakes? Brother, you just don't dig up the wrong side of a road, making a mistake that may cost thousands of dollars, and then forget about it! Not if you're the kind of guy who can manage a business successfully for twenty years by depending on not making mistakes like that.

What about that "subconscious reaction to imperceptible hints" theory? Has it been checked? Has anybody tried to see if the human mind *is* capable of doing any such thing? Somebody should! The mechanism would be useful if it could be controlled. If police could be trained in its use, Sherlock Holmes would be outclassed by every good detective who had been trained in the art.

(As an aside, I might mention that I visited the Police Department while I was in Milford, and I had the pleasure of meeting Sergeant Angelo Marino, a big man in his middle thirties who is almost the perfect stereotype of the tough, burly, efficient, but very kind-hearted cop. We got to talking about police work, and I said that it was odd how frequently a police officer, with no apparent evidence, will investigate something or someone on a "hunch" and have his hunch verified.

"If a man *doesn't* get hunches like that," said Sergeant Marino, "he's not going to be a very good cop."

Is there any relationship between that ability and the ability to use the pipe locators? I wonder.)

Or do the locators operate on some definite, but heretofore unknown

physical principle? Is it possible that, just as the science of hydrostatics cannot predict the effects of *moving* water, modern field theory is not inclusive enough to encompass this particular effect? I don't know, but certainly someone should find out. The phenomenon is there, and any science which is trying to explain the workings of the physical universe should certainly include *all* observable phenomena, not dismiss some as "non-scientific."

Or, last and a hell of a long way from least, do the locators operate on some psionic principle? Is there some kind of extrasensory perception involved, by which the operator perceives the pipe subconsciously and that information is transmitted to the nerves and muscles controlling the rods?

I am and always have been irritated by the complacent feeling, manifested by so many people, that "we know how things work now because we have all the answers." Damn it, ignorance may bring some kind of bliss, but it is a dangerous kind of catalepsy to sink into, and it is *not* folly to be wise. No matter how beautifully a set of postulates fits together to form a structure that explains a given set of phenomena, one single phenomenon which can *not* be explained should call for a re-examination of the postulates, not the development of a

blind spot, so that the intruding discrepancy can be politely ignored.

Fortunately, there are, and there always have been, men who will look and observe and theorize and check their theories, without saying, "That is impossible according to what I know, therefore it doesn't exist." Nor, do these men point a finger and say, "That's *his* department, not mine." Especially when they do not know what department the phenomenon is included in!

Nor are these men saying, "Gee whiz, I'd like to experiment with those things, but if I do everybody will think I'm a nut."

A scientist worthy of the name—and there are a few—does not think anybody is a nut just because he investigates a phenomenon. Those who do are not worthy of respect and it is no loss to the investigator if they *do* think he is a nut.

I, personally, am doing some work on these particular gizmos. If and when I come up with anything new, I'll let you know. But bear in mind that I am, primarily, a writer, not a scientist. These days, it takes, at the very least, a Ph.D. to swing very much weight in scientific circles. I am simply not qualified to do scholarly research.

Meanwhile, Mr. Harry C. Ritchie and Mr. Herbert Ahrens are going quietly about their business of running a water company, and they are doing very well at it, indeed. ■

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MULTIPLE CHOICE QUESTION:

It takes . . . for light from the nearest known star to reach Earth. 1: Five years. 2: Two months. 3: Eight minutes. 4: Three seconds. Answers on page 169