Chicken-Wire Chemistry

BY J. D. RATCLIFF

DRAWING BY KENNETH W. THOMPSON

That's what the chemists call it when they work with natural gas, because of its bizarre molecular patterns. It's one of our most valuable natural resources. From it, we can make plastics, anesthetics, dyes and other products

IF YOU looked in a neighbor's cellar window and saw him stoking the furnace with perfume, alcohol, synthetic rubber and valuable drugs, the chances are you would call the paddy wagon. But if your neighbor is using natural gas as fuel, you wouldn't give the matter a second thought. Nevertheless, all these things and a great many more are being derived from natural gas.

Natural gas is a fabulous natural resource. It is the raw material for a postwar chemical industry which can dwarf the coal-tar industry we built a generation ago.

We all accept the idea of drugs, dyes, plastics derived from coal tar, but the idea of taking a colorless and sometimes nearly odorless gas issuing from the ground, and changing it into synthetic rubber, motor fuel, edible fats, fertilizer, explosives, anesthetics, flavoring, potable alcohol, and even perfume may be a little hard to take. Not for the chemist. He takes such magic in his stride.

It is his job to take atoms from a cheap and plentiful stuff and restring them to make valuable materials. If this isn't completely clear, visualize atoms as beads. Beads are strung in a variety of patterns, to make necklaces, bracelets, beaded bags. And so with atoms. It just happens that natural gas is a bountiful provider of desirable atoms.

To get some notion of the dazzling possibilities that await postwar development, note a statement of Doctor Gustav Egloff of Universal Oil Products: "If one starts with natural gas, all the known synthetic products that man has developed in organic chemistry can be derived—and there are over 500,000 different ones."

No geologist is sure of the source of natural gas. The best guess is that it derives from deposits of organic matter—plants, animals, fish—laid down a million years ago. Caught in geologic traps, gas sometimes reached tremendous pressures—up to 4,500 pounds per square inch. It is this gas pressure that forces oil to the surface; that makes gushers gush.

Man has known and used natural gas for 2,000 years. The ancient Chinese drilled wells, and used bamboo piping to carry gas to evaporators which reduced brine to salt. Street lighting, first large use for gas—both natural and manufactured—arrived little over 100 years ago.

Industrial uses followed. Vast quantities of gas supplied heat necessary in cement making and oil refining. It provided fuel for heating homes and making electricity. Ten per cent of the national supply was burned to produce carbon black. Carbon black is mixed with rubber to make tires; and to make paint, stove blacking and printing ink.

These uses were once accompanied by prodigious waste—half the gas we produced. After gas pushed oil to the surface of the ground, it was burned. Thousands of flares lighted the night sky of Pennsylvania, Oklahoma and Texas—to our everlasting shame before future generations. Gasoline was squeezed from natural gas; and the resultant dry gas was released into the atmosphere. Uncapped wells gushed billions of cubic feet of natural gas into the air before conservation practices put an end to such waste.

Such waste was permitted because chemists thought natural gas was so inert, so unreactive, that it couldn't be changed into other products. Then came a chemical revolution.

Components of Natural Gas

Natural gas isn't a homogeneous stuff. Some "natural gas" is nearly 100 per cent carbon dioxide. Instead of burning, this gas smothers flame. But, for the better part, natural gas consists of four inflammable hydrocarbon gases—gases consisting of hydrogen and carbon atoms. They are methane, ethane, propane, butane. Methane, the lightest, is the most common—making up about 90 per cent of all natural gas. This same gas is generated in marshes, sewers, human intestines.

Butane and propane are familiar as the bottled gas used in homes not served by pipe lines. They are also used as fuel for 25,000 trucks, tractors and busses in the United States.

In addition to these chief constituents, natural gas contains lesser amounts of other things: pentane, hexane, heptane, helium (for inflating dirigibles). It is the first four, however, that hold such dazzling possibilities for chemical industry.

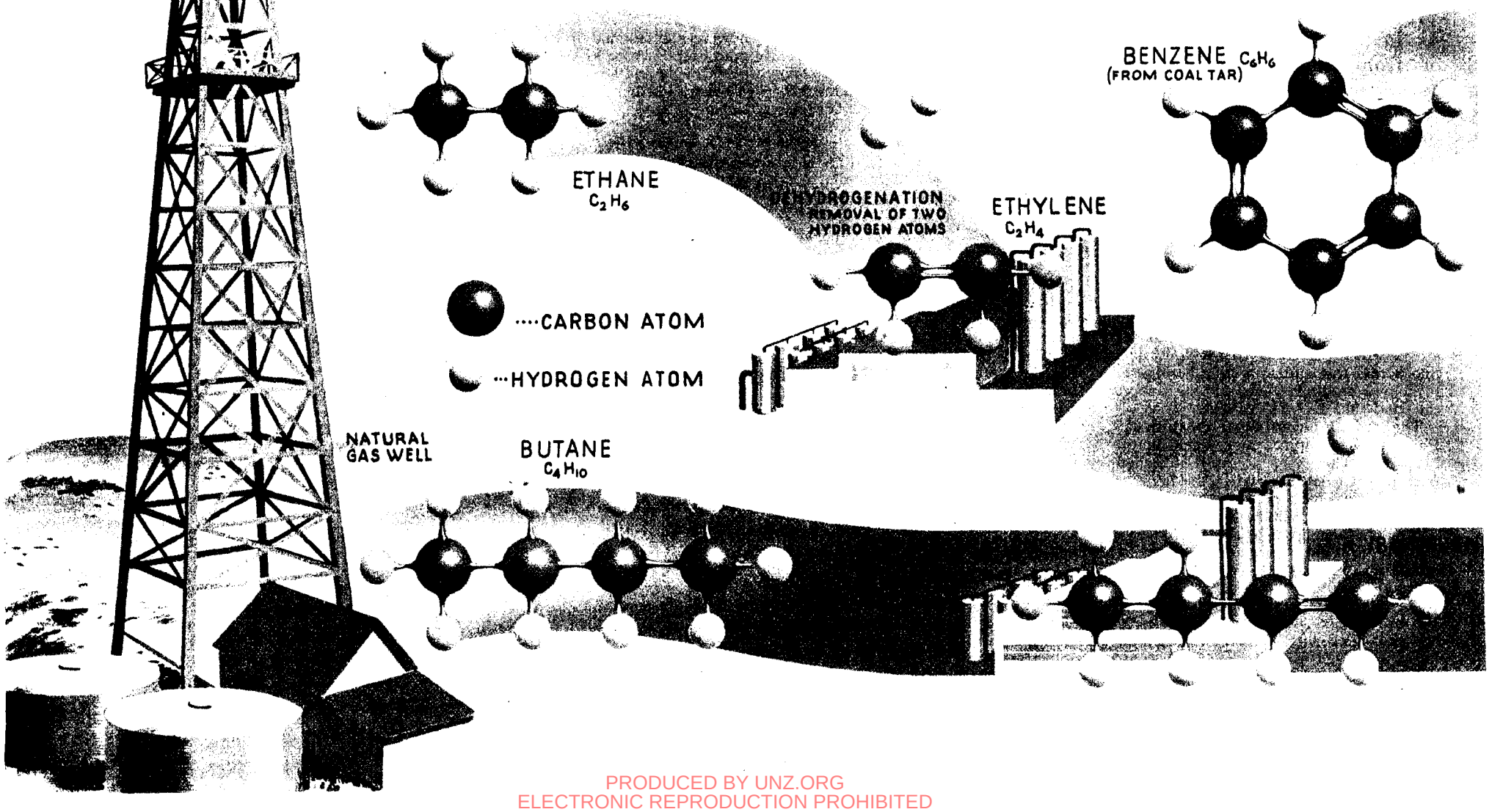
The idea of retailoring these gases into solid articles of commerce made no headway until the early twenties. The first break came by accident. A group of chemists working for one of the oil companies drew the problem of studying corrosion in natural gas pipe lines. They suspected that corrosion was caused by the interaction of gas and air.

To reproduce conditions artificially, they mixed gas and air, and put the mixture under heat and pressure to hasten any reaction that might take place.

They were totally unprepared for what happened—something which chemical texts said could never take place. When they opened the metal pressure chamber, they found condensed droplets of wood alcohol, formaldehyde and other chemicals. It was easy enough to guess what had happened. One atom of oxygen had combined with one molecule of methane to make wood alcohol; two atoms of oxygen with methane to make formaldehyde. Both these materials were needed in huge quantity: formaldehyde in making plastics of the Bakelite type; wood alcohol as a solvent for lacquers. The oil company promptly built a plant in Oklahoma to put the process to work.

This was a meager beginning for the next chemistry—called "chicken-wire" chemistry because of the bizarre patterns atoms take in molecules. Chemists went on to perform other miracles which directly contradicted earlier beliefs.

They learned how to pry the methane molecule apart—thereby getting carbon and hydrogen. The carbon went into tires. The hydrogen was mixed with atmospheric nitrogen to make ammonia. The ammonia, in turn, was converted into explosives and fertilizers.



Chemical architects redesigned the butane molecule to make butadiene, the basis for the better part of our synthetic rubber. They made plastics like vinylite; solvents for photo film; antiknock fluid for automobiles; Cellophane and a host of other things.

From the layman's point of view, one of the most startling developments came when chemists found how to start with two gases—oxygen, and the ethane component of natural gas—and end up with purer alcohol than was ever made by fermentation and distillation. They did other tricks with the ethane molecule. By chipping off two atoms of hydrogen, they produced ethylene. This gas is used to make thiakol and other synthetic rubbers. It stimulates growth of tomatoes and potatoes, and ripens citrus fruit.

The fascinating ethylene molecule —C_2H_4—made jobs for thousands of men at South Charleston, West Virginia, home of the vast Carbide & Carbon Chemicals Corporation plant. It is converted into ethylene glycol—better known as Prestone, the radiator antifreeze. It also goes to make diethylene glycol, used as a moistening agent for cigarette tobacco, as well as scores of industrial chemicals.

Giant networks of pipes feed natural gas into the plant. By fractional distillation, ethane and other wanted components are removed. The rest of the gas goes into pipe lines—to feed stoves and furnaces of near-by Charleston. Chemical wizardry extracts an incredible array of products from the gas while it is in the plant: ether in tank-car lots, base materials for plastics and rayon, lacquer solvents, refrigerants, insecticides, dyes.

Gas chemistry has moved so swiftly in the last few years that it has left chemists with many baffling headaches. To get a wanted substance, it is often necessary to produce staggering quantities of unwanted materials. Then the problem arises: What to do with the unwanted stuff?

One company was faced with this situation: Tens of thousands of gallons of unwanted ethylene dichloride accumulated. It filled every available storage tank, and no one knew what to do with it. Then the bottleneck broke. The chemical was found to be an excellent dry-cleaning fluid, and a powerful chemical weapon against the peach-tree borer. The material changed overnight from a headache to a valuable commodity.

It would be virtually impossible for us to wage winning war against the Axis without gas chemistry. This lusty new industry produces ammonia for explosives; butadiene for synthetic rubber; plastics for bomber noses; chemicals for the degaussing cables which thwart magnetic mines.

"Natural" gasoline, extracted from gas, is one of the chief blending agents for the 100-octane gasoline that gives our fliers such a tremendous edge over the enemy. Natural gas is providing a vast array of medicinals—one of the most interesting of which is cyclopropane, the new anesthetic which leaves none of ether's bad aftereffects.

Heat Treatment of Metals

Natural gas is being used in the metallurgical trades to provide "designed" atmospheres for heat treating. Heat-treat a piece of steel in the presence of air and it comes out of the furnace covered with scale. Heat-treat it in natural gas—which contains no oxygen—and it comes out shiny, ready for use.

To enumerate all the ways in which natural gas is entering the war effort would be a staggering chore. The point: It is everywhere. It is one of the biggest—perhaps *the* biggest edge we have over the enemy. Germany has to depend on coal for her chemicals. Natural gas is a cheap short cut for us.

The know-how which chemists have gained under stress of war will be invaluable when peace comes. Natural gas will be the basis for new industry, new jobs.

Gas chemistry is already playing an important role in civilian life. We sleep on bedsprings tempered with gas, wear rayon pajamas that trace to it. We brush our teeth with dentifrices containing gas chemicals, drink juice from oranges ripened with ethylene. And so it goes throughout the day.

Important though all these applications are, chemists believe that we have barely scratched the surface of gas chemistry. Natural gas is one of the most widely available of all natural resources—being found in 37 of the 48 states—and it is cheap. A 300-pound barrel of crude oil costs around $1.35. A comparable weight of natural gas at the well costs from 1/5 to 1/3 as much.

Most of the processes we have seen have been developed in the past decade. Going at an ever-quickening tempo, gas chemistry has made tremendous strides in the past five years. Since war started, revolutionary advances have taken place. Only now are eyes fully opened to the possibilities that lie ahead. Natural gas promises to take us into a new chemical era.

Most geologists are agreed that we face exhaustion of domestic crude oil in the next few decades. What happens then to a motorized civilization? Many people say we will make gasoline from coal or from oil shales. Gas chemists say not. We will get the necessary gasoline from natural gas. Cost favors their argument. Gasoline made from coal would cost 16 to 18 cents a gallon. From natural gas, cost would be 9 to 12 cents.

You may ask, will all these postwar chemical plants, based on natural gas, be located in the Texas, Louisiana, mid-continent and other fields? Not necessarily, because the engineer comes along with an idea that has striking possibilities. He proposes hauling gas by barge from producing to nonproducing areas! Then

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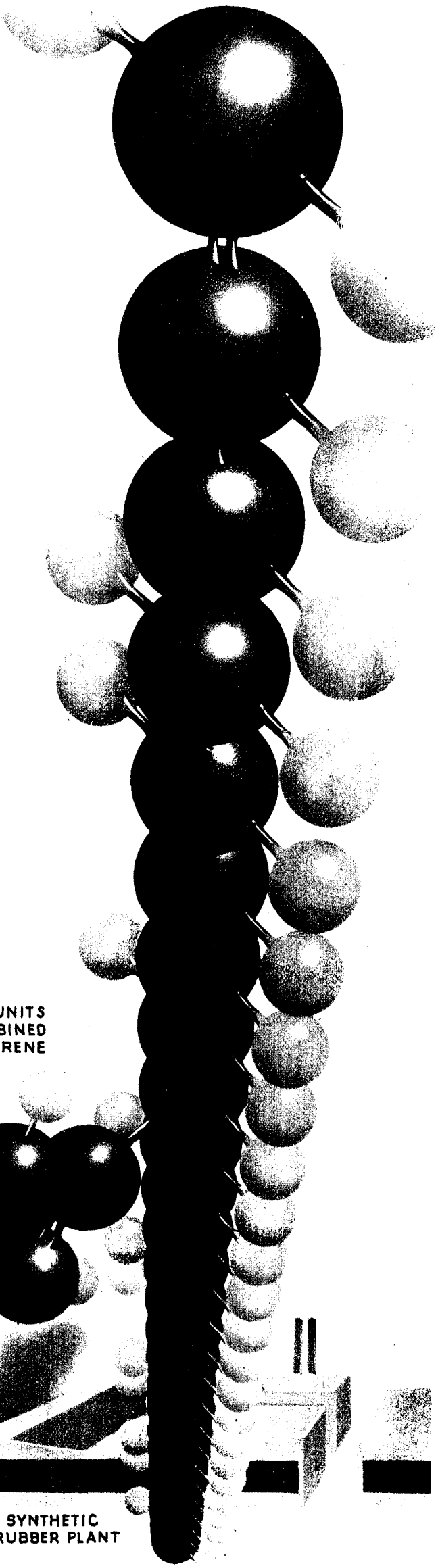
How synthetic rubber is made from natural gas: Here are the complex steps through which the chemists juggle inflammable hydrocarbons of natural gas, subtracting and adding atoms to produce in the final synthesis, Buna S



COURAGE ISN'T EVERYTHING

BY GEORGE HARMON COXE

ILLUSTRATED BY CHARLES LA SALLE

She didn't know he was coming back to her—and neither did he—but certain things brought them together, including a knowledge of what constitutes fear

Boyd took Claire in his hands, holding her. "You're afraid," he said. "For Verna?"

WHEN she had finished her song and the spotlight had gone out, Neil Boyd sent the waiter out with a message. Now he watched her come from the doorway beside the orchestra shell, smiling, nodding to some of the tables, a tall, ash-blond girl with a slimly sumptuous figure and a dark blue evening gown. He stood up as she approached, aware that she was hurrying now, that her smile was only for him.

"Neil," she said. "Why, how wonderful!"

"Hello, Claire," he said, and for a moment, holding the two hands she offered him and seeing again her smile and the sparkling warmth of her eyes, his chest was tight with emotion and his heart was hungry; then he remembered where they were and the moment passed, and he began to think again. He let go of her hands.

"But why didn't you let me know?" she said. "I had no idea you were comng."

"I wasn't sure myself. I got in last night."

They sat down and the five-piece colored combination stomped into Margie. Some of the Club Eden's patrons began moving toward the two-by-four dance floor, and business picked up at the bar. Neil Boyd looked back at the girl. She was still smiling, leaning toward him across the table, but concern and something else he could not diagnose tempered the warmth of her eyes and altered her voice.

"You're not in uniform," she said. "Does that mean—"

"The Navy decided they could get along without me," he said, and though he tried to speak without resentment, there was an intensity to his words that made her regard him curiously.

"I'm sorry. It must have been bad if—"

"I'm all right now."

He sipped his ale and asked if she'd have something. She said no and he glanced again about the narrow smoke-filled room, the doubt he had felt when they told him she was working here all gone now, and in its place, dismay and disappointment and a mounting bitterness that was difficult to control.

For she was not the girl he remembered. It was not just the make-up which gave her a polished luster he did not know, nor that she was singing in this trap, nor even that she was working again for Sam Verna; rather it was a combination of the three. Suddenly he was glad he had not let her know he was coming.

"I got in last night," he said. "I would have stopped over to your place this afternoon, only I didn't think you'd be home." He waited until she looked at him. He said, evenly, "I thought you were working in a defense plant."

Color whipped to her cheeks, and her gaze was suddenly stricken. She started to speak, checked herself, and then the pain in her eyes clouded and grew remote. He glanced up to find Sam Verna at his elbow.

Verna smiled, a slim, dinner-jacketed man with a boutonniere and sleek black hair. "Hello, Boyd," he said. "I hear for you the war is over."

Neil Boyd examined him silently.

Presently Verna's smile died out around the eyes. "For a guy who was reported missing and then wounded," he said lazily, "you look okay. Doesn't he, Claire? . . . When does it get to be Detective Boyd again?"

"As of today," Neil told him.

Verna said he was glad to hear it. He leaned down and covered one of Claire Marden's hands with his own. "If Mr. Boyd will excuse you," he said, "there are some people I'd like to have you meet."

He picked up the hand and smiled at her, and Claire Marden rose. Neil Boyd stood up, feeling the stiffness in his face, unable to smile. Her gaze touched his and slid past, revealing nothing. Her voice was low, controlled: "If you should want to stop by, Neil, the afternoon is a good time."

"Maybe tomorrow," Boyd said. "Late."

He watched her sit down at a table where four men and two women waited. After that, he tried not to look at her. He found his ale flat, like his hopes, but he did not order another. He sat staring straight ahead—a dark, solidly built man, with steady eyes dully brooding. After a while, he paid his check and went out. His coupé was parked down the street, and he climbed in and slammed the door.

He did not start the car but lighted a cigarette, and gradually the tension left him. His bitterness moderated and became less astringent. When he asked himself what, after all, he had expected, he had to admit he did not know.

He had seen her twice—three times if you counted the time in the station house—two years ago; there had been eight letters that he had answered. Yet for all of that, there had been a definite picture in his mind while he had been away, a picture that warmed him strangely and filled him with a happy excitement each time he thought of her, like having some delicacy upon a shelf, untasted but of proved quality; of knowingly saving it for some future time and enjoying fully the anticipation of the final tasting.

She was twenty-three when he first saw her, and that night, as on this one, she had been singing for Sam Verna—not at the Club Eden, but at another, shabbier place farther downtown, with a stairway out back that led to rooms above where certain favored patrons were permitted to try their luck at roulette and blackjack. Claire Marden was in the middle of a song when they raided the place, but it was not until afterward that Boyd had a chance to study her.

What he saw then was good. Even with her evening gown and make-up and everything about her looking out of place against the musty atmosphere of the precinct house, he liked her. It was not just that she was pretty. The way she carried herself, the way she spoke and the things she said impressed him. There was no coarseness in her, none of the scornful defiance he had expected from one who sang in Sam Verna's place. Instead, there was a quiet courage in her manner that seemed untouched by what had happened, a certain dignity that stirred him deeply and left him strangely moved.

HIS excuse, when he stopped at her apartment the next evening, was that he had to check up on some things. He learned that she was an orphan, that she had worked as a clerk in a woman's shop until her mother died and that later, through a friend, she had found a job as a hat-check girl because she could make more money and because the work seemed less drab and lonely. Sam Verna had seen her there and one evening, stopping in early when the place was empty and Claire was singing the chorus of a song the piano player had written and wanted to try out, he had been impressed and offered her a job.

Boyd was never sure how he got started on his lecture. It might have been because he knew what it was to be alone; perhaps it was simply that he liked this girl and was afraid of what might happen to anyone who worked too long for Sam Verna. Whatever the reason, he found himself telling her she was making a mistake. He had, he said, seen a lot of Sam Vernas in his business. He had seen a lot of girls who once sang for Verna and others like him.

"What does it get you?" he asked. "In a trap like that? Fifty bucks a week—if you're lucky."

She watched him curiously, a half-smile on her mouth. "That's a good guess," she said.

"You could make that much doing war work, once you'd been trained. Suppose it is tougher than singing for Sam. It would be worth-while, wouldn't it? Doing what you could to help with the war, you could be proud."

He said other things, and though he had

(Continued on page 49)