TAMING OUR FORESTS

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INTRODUCTION

Our country is getting pretty full of people. There are about 127,000,000 of us now, and it is reasonably certain that by the end of the century there will be 150,000,000. Because there are so many of us and because we need so many more things to make us prosperous and comfortable than people have ever needed before, we must get more from the mines and the rivers and the soil—and much more from the forests.

Although one-third of our country is forest land—615,000,000 acres—we are not even getting as much wood from it as we use now; far less than we shall need when there are 150,000,000 of us. Already we are bringing it in from other countries.

Is that what we must do—import more and more wood as there are more and more of us?

Not if we tame our forests so that we will get better service from them, domesticate them as we have domesticated horses, wheat, cabbages, and hens.

We expect from our forests wood for such things as houses, railroad ties, paper, rayon, movie films, and fruits, nuts, game, and turpentine, as well as places in which to rest and play. We expect them to protect our land from erosion by wind and water and help us to control floods.

Trees cannot serve us in all these ways if most of their energy is spent in a struggle with each other for light and water and soil.

In the sort of community which a forest creates for itself one species of trees usually dominates the rest. These have fought their way up through a long merciless struggle of tree with tree, one kind against another, no quarter given the defeated. After the dominant trees have taught all the others their places, then there may come a sort of armistice, a truce, a pause in the conflict when the forest is said to have reached a climax. But, however serene a "climax forest" may appear, there is no more peace in it than in a boxer lightly poised to land the next blow. It is because this forest

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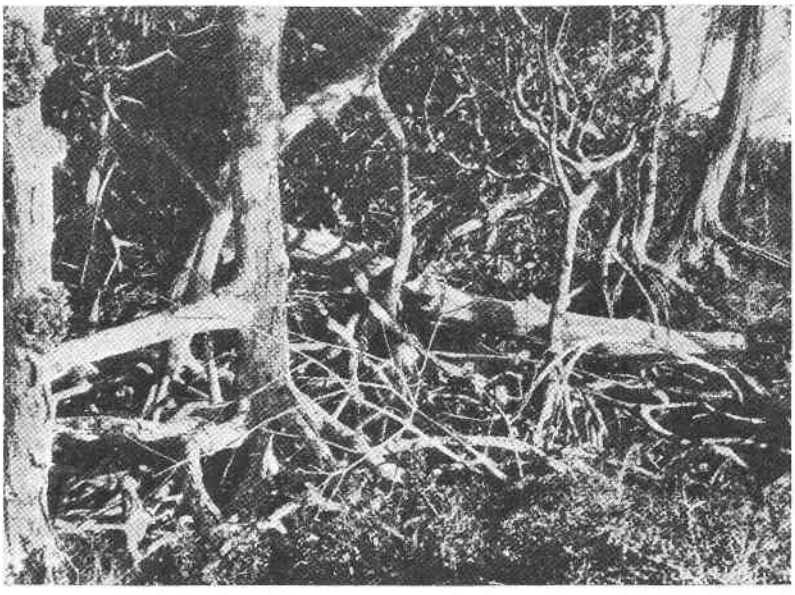
WILD FORESTS

It is hard to realize when we see the beauty of a wild forest that we are looking at a battleground. Hard also to understand that the trees which compose it do not constitute anything like the best crop that it could give us, any more than the wild cherry trees in the New York State woods give a crop comparable, in terms of pies, with a cherry orchard.

Take for instance the trackless, uninhabitable forest in southern Florida. The red mangrove marching out into the sea in rows of columns 50 feet high protects it from the ocean. The tides gurgle up and seep back through the mangrove roots, which hold fast to the bottom. New seedlings drop among these roots; drifting things catch in them, mud and silt settle about them so that not only does the mangrove guard the coast, but it is continually forming



Mangrove forest, Everglades.

new land. Back of the red mangrove with its fragrant leaves, the black mangrove, and the white, the protected land rises in what are called "hammocks" interspersed with sawgrass marshes. Upon the hammocks is a low wild jungle of tropical hardwoods. There is the gumbo limbo tree with a trunk of glistening copper bronze; the strangler fig, letting down a veil of heavy meshed lace, the floating gray banners of the moss, and through it all the perfume of perpetual bloom. The white ibis nests there and the roseate spoonbill and the sand-hill crane. The flamingo makes it a winter visit and the white egret and the great blue heron.

Pine grows there, and we perpetually need pine. But this is Caribbean pine, a poor wood. There is the mahogany tree. For 200 years we have considered the chairs and tables of its rich brown wood the most beautiful we could get. On the Florida hammocks the mahogany tree flourishes. Its leaves are green all the year round. In midsummer, it is covered with lilac-colored flowers. In December it hangs full of seed pods that look like turkeys' eggs. But the dark-red wood which we so prize does not come from this tree. No wood of great value grows in the Everglades.

This southern forest has grown to suit itself since the coral animal began to build up the Florida Keys, but it has little to give us except a beautiful picture and a laboratory for study.

If we start northwest from these wild tropical everglades at the tip of Florida, we will travel over the longest diagonal that can be drawn in the United States. First we cross through the yellow pine country in north Florida and in Alabama—a no man's land, raged over by man and by fire; then through northern Mississippi, where the water is stealing the soil from between the rows of cotton on the cut-over lands; on through Arkansas, where the bare sides of the Ozarks have been torn and gullied by the rains; over the Kansas prairie and the plains of Nebraska, where no trees have grown since the Rocky Mountains rose toward the sky; through the Wyoming pasture country; up into the forests of Idaho on the old Bridger Trail, which the covered wagons followed;

across the "Inland Empire" with the Oregon Short Line; up over the Cascade Range and the Olympics; and down to the Washington coast, where an untamed forest of Douglas fir faces the Pacific as the mangroves of Florida face the Atlantic.

Early in April, when the growing time of the trees has begun, winds start to blow in from the Pacific. They have crossed the current of water which is warmed by the sun in the Tropics south of Japan before it flows up and across to our northwest coast, and they come to land heavy with drifting fog and soft warm rain. From April till late October they drench every needle of the trees, and fill the soil about their roots like a sponge. No bitter cold ever touches this land, nor heat, nor drought. It is as perfect a place to grow trees as the irrigated fields along the Rio Grande are to grow alfalfa. In this favorable climate—this perfect environment—the Douglas firs grow and grow. Next to the giant sequoias and the redwoods, they are the largest trees on the continent. Their huge straight trunks shoot up 100, 200, and 300 feet into the sky. The first branches are as far from the ground as a housetop. Below them grow other conifers: Western hemlock, Sitka spruce, silver fir—humble cousins of the great trees. There is a dense undergrowth of ferns as high as your shoulder, and the moist forest floor is littered with giant trunks rotting away.

This untamed forest is vast and dim and heavy with the scent of fragrant wood. It has a beauty that not even the white pines can equal. Six out of ten trees in it are Douglas firs, the trees most important to men of any that grow west of the Mississippi. And yet this wild forest is producing only about one-third of the timber it is capable of bearing. It is as though a fertile field grew only one stalk of corn to the hill.

If instead of going straight from Florida to Washington, we had turned north through Tennessee and Kentucky and crossed the Ohio River instead of the Mississippi, we would have come into the region of the central hardwoods—the broad-leaved trees.

The land has had thousands of years of preparation for the growing of trees, but on the territory this forest covers there is less than one great tuliptree, gum, or oak to the acre, and these are the trees we want. They stand out like Knights of the Round Table because they are so few.

In northwestern Pennsylvania there is a wild forest called "Heart's Content." It covers a series of narrow valleys and steep hillsides broken by bare rocks. There are natural terraces and high among them clayey swamps, rock-covered wastes, and flood plains. It is a cool land with a wet wind blowing across from the Great Lakes from February until August, while the trees are growing. Then the wind swings farther to the south and sweeps up from Texas across the Mississippi and on through the valley of the Ohio. There is plenty of rain and during the winter there is nearly 6 feet of snow. It is a good place to grow trees.

About 250 years ago Heart's Content was swept by fire. Nobody now alive saw the fire. Nobody knows how it started. Nobody wrote about it. Nobody even told anybody about it. But a fire is the only cause for the situation which we find there now. All the trees on the hills were killed except a few young hemlocks which could resist the fire and a few old white pines that bore seed. It was probably a ground fire. We do not know what trees besides the hemlocks and white pines were in the forest. What we are sure about is the approximate date of that fire. We are sure of this because the age of a tree can be discovered by counting the rings that form around its center—one every year. Twenty rings mean that a tree is 20 years old. By counting the rings on white pines that have fallen at Hearts' Content, we find that most of them are 250 years old, and so we know that about 250 years ago a new pine forest was seeded from old trees now gone. Slowly they pushed through the underbrush that sprang up after the fire and shaded them from wind and sun. Very slowly they grew for 5 or 6 years, as white pines do. The young hardwoods—chiefly beech, yellow birch, black birch, maple, and chestnut, which began with them—grew much faster than the pines and gave them

a light shade. But when they were 5 or 6 years old the young pines began to speed up. They distanced the hardwoods. They caught up with the hemlocks, which had had a century's start of them, and shot up 140 feet into the sunlight. Some of the young beech trees grew up along with them and helped to form a dense canopy of leaves through which almost no light could fall. Below the canopy of pines and beech, the older hemlocks formed a second roof, increasing the darkness below. The hardwood trees, birch, maple, and oak, which could find little to live on in the dim light of the forest, were left far behind in this slow race and formed a third canopy that deepened the shade still more. Far below on the forest floor was a cool, dark, damp place where the seeds of the white pine trees sprouted easily, but where they did not flourish. The final test of supremacy in a forest is whether a tree can bring up its young. There must be heirs to the throne. The young white pines die when they are tiny seedlings though the old trees have kept dropping seeds down from the forest canopy for 200 years.

Now, Heart's Content is a lovely thing, a scientific laboratory, a delight, and a comfort; but as a source of supply to man it is not satisfactory. Why? White pine is among our most useful trees, and in that wild forest it is being crowded out.

These wild forests, these wilderness areas which we are preserving, cover nearly 10,000,000 acres, and they give us pleasure and information—they are vastly important. But we can no more depend on wild forests like these to give us what we need in lumber than we can depend on wild antelopes to give us what we need in meat. Only from the forests which we tame can we expect a continuous supply that will help us to build a secure and increasing prosperity.

WHAT A TAMED FOREST IS LIKE

It is not easy to tame a forest that has had its own way for hundreds of years. Trees have habits and customs of their own. A wild forest takes no responsibility for furnishing a perpetual harvest of good, useful timber. What it has the habit of growing is an occasional giant leader and a tribe of inferior trees.

There is, up in the Chippewa Forest, in Minnesota, which is being tamed, one of these dominant trees, a vast white pine which towers above all its neighbors. The foresters say that it has stood there between 400 and 500 years. It is some 9 feet in diameter, and the roots slant out from the trunk like buttresses supporting a cathedral pier. The foresters have an affection for that tree.

"Hope you stay with us a long time, yet, Old Girl," said one of them, and laid a gentle hand on the bark.

For centuries that tree has been opening its brown cones and releasing pairs of winged seeds to the wind, in some years only a few of them, but every 5 or 6 years, seeds in a flying cloud. It has been the parent of many seedlings, but its descendants are not around it now. They must have sprouted, these seedlings, thick on the forest floor, hundreds and thousands of them as the years went by. Hundreds and thousands of them went to feed squirrels and birds; thousands rotted away; but other thousands lived and grew. They pushed up through the litter of needles and leaves and branches; they tried to get enough water and food and light to grow on. The weaker ones were starved to death, and the stronger ones grew on—fewer and fewer of them as time passed. Not so long ago the lumbermen came through that forest, cut out the younger generation of pines, and sent them to the sawmill. But for all the seeds the great old tree had scattered, it was plain that not many pine trees had lived to grow up, for there are not many white pine stumps within range of those flying seeds. There are signs of age on the great tree now; the buttresses are scarred and weak; there is rot at the root; when the winds sweep down from the north again it may fall before them; and there is not one white pine left to send out seeds in its stead. White pines,

which are the most valuable trees that northern Minnesota can grow, could be springing up all through that forest now if it were treated like a garden bed, and the white pines given the first chance as the gardener gives the first chance to his young tomato plants.

There is one of these tamed forests—a forest of Norway pine—not far from that old white pine. A few great trees stand above the others and sing in the wind. They must have sprung from seed that fell before any white man broke trail through that wood. Below them is a carefully thinned stand of their descendants about 50 years old—slender, straight, clean of branches for 20 feet, and swaying like seaweed in the faint violet light that is reflected from their colored trunks. They stand close together, for it is not the purpose of the forester to let them each have all the light they need without climbing far up to get it. They must crowd each other enough so that they will develop the tall straight trunks which give us the most valuable lumber. Farther down is a thick stand of 10-year-olds stretching their crowns toward the light. Close to the ground are the seedlings with a hundred years of growing ahead.

In these young forests which are being so carefully tamed there will be no great pine left without descendants. Barring fire, there will not have to be any replanting either, for the foresters know how to assist a forest in bringing up its young. A well-started, well-established, well-weeded, and well-cared- for forest can do its own replanting and furnish us with a perpetual crop.

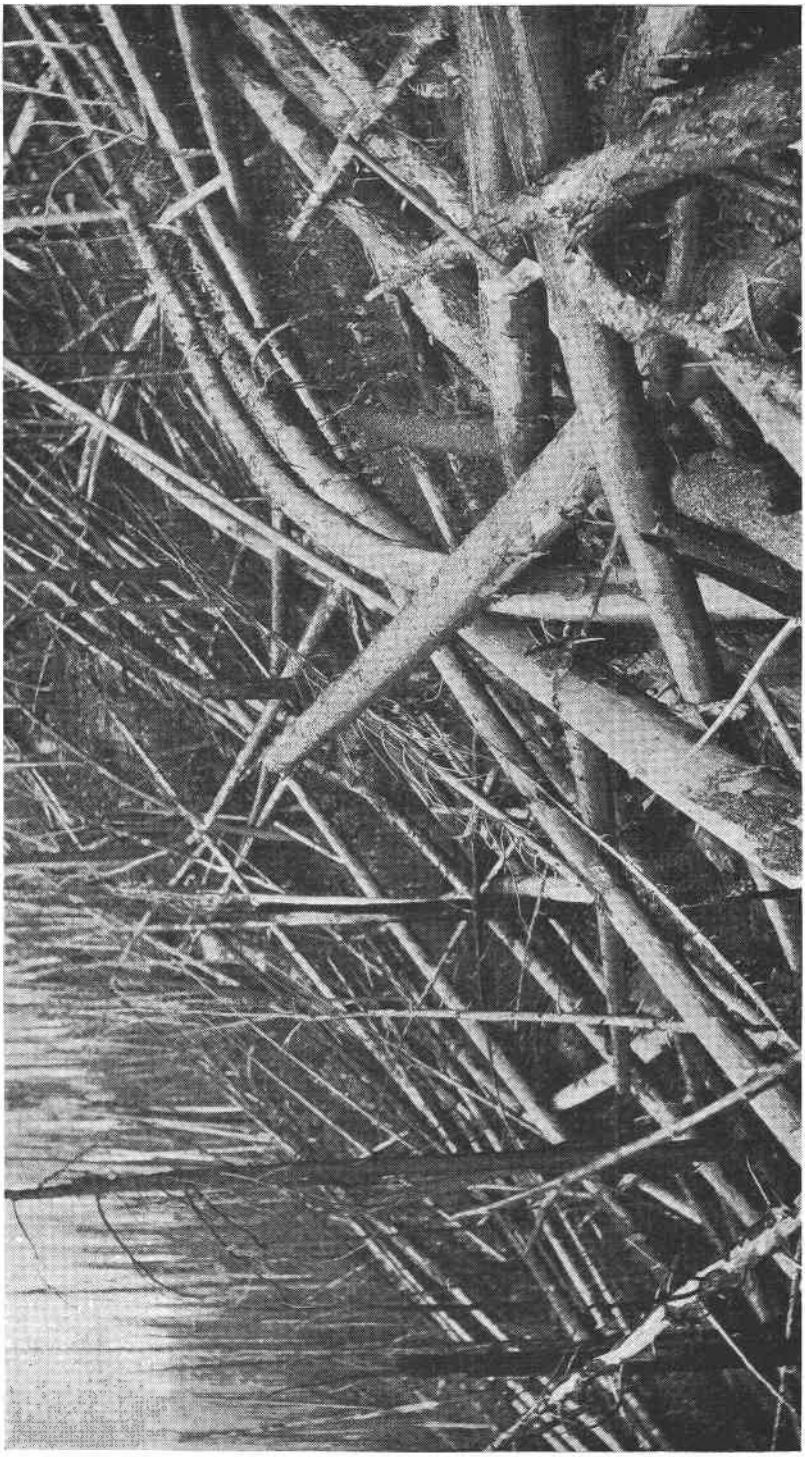
So long as the seeds of the trees which we need do spring up and take root, so long as there is generation after generation growing up through the forest, so long as bare land is being covered with a new growth of useful trees which are not starved out by weed trees or crowded out by each other, we may leave the bringing up of the young forest to the old trees. Just so long and no longer! For we cannot permit a forest to exist for the production of a few giants. What we must train the forest to grow is a high average of board feet, year after year after year.

No amateur can adequately break in a wild forest to the service of man. It is a job for a trained forester. First it is necessary for him to realize that forests are for the service of human beings, and to know what the 127,000,000 American people need that the forests can give them—whether it is boards and heavy timbers for railroad ties, or pulpwood, of which to make paper, or turpentine; or perhaps protection of the soil. Then he must know what sorts of trees will supply these special demands and whether the particular forest he is considering can be induced to produce them.

He must know the nature of the soil, how deep it is, and whether it contains the food that trees need, whether the winds will bring enough rain or whether there is an underground water supply—a good water table—to be counted on. He must go through that forest and see just how he can treat it so that the important trees will get all the room they need and all the soil and sunlight and water they can use. Are they close enough together so that they will grow tall and straight in their effort to reach the light, or are they so far apart that they grow wide and bushy like an apple tree in an orchard, with practically no tall trunks out of which long boards could be sawed? He must see how the seedlings are being brought up—whether there are enough trees of the sorts that enrich the soil such as birch and beech to keep them well fed and enough "nurse trees" to protect them till they are old enough to take care of themselves.

When he knows what he wants to get from that forest and what the chances are of his getting it, then the forester must begin to break it in to do the work. There are the trees that have reached maturity and are ready to be cut and sold—these must go. There are what are called "wolf trees"—trees that reach out to steal another tree's share of light—there are misshapen or diseased trees, or trees of worthless kinds that occupy space—these must go. There are places where so may trees of even the most valuable kind are trying to grow that they starve each other—these must be thinned, as a gardener thins out the extra carrots in a row. And that forest must be so regimented that there will be pushing up slowly layer by layer, generation after generation, trees for a perpetual harvest.

Idle acres.



They Cannot Reseed.

NURSE TREES

On some of this land the nurse trees can make reforestation possible without any assistance from us. That problem of the nurse trees is a very special one. If a seedling can be spared the strain of fighting for its life while it is very young, it has a better chance to grow to a fine, upstanding, valuable tree. The problem is the same that meets every human parent who must decide whether to send his child to school or into the mill. The white birch and beech stands that grow so easily in Michigan and Wisconsin, enrich the land they grow in and protect the other trees that come after them.

The aspen is a good example of a nurse tree. It is low-growing with a thin crown that does not cast a heavy shade. Its trunk is not even thick enough for good firewood. It grows from the Arctic to the Ohio River and from the Atlantic to the Pacific. It is almost useless as timber, but where a forest is destroyed by fire, as some 40 million acres have been, the aspen comes back quickly to shade the soil. Under protection, young trees of the better kinds grow up, push their way through the low roof of leaves, and form a higher leaf canopy of their own. The higher they reach into the sun, the denser the shade they cast upon their aspen nurses below. Now aspen can root in sand or clay and live in spite of wind and drought and cold, but it can't survive deep shade. Its service is done when it has taken burnt-over cut-over wasteland and held it till other trees have started and are on their way to maturity. Then it dies and leaves all the sun and rain and plant food to those young trees it has brought up.

PLANTING A FOREST

With all the millions of acres which have been cut bare or burned bare with no old trees to seed them again and with our increasing population and our need of the things that forests can give, we cannot wait for the old slow ways by which forests cover the land. Seeds dropped directly to the ground do not go much farther than twice the height of the parent tree. Seeds flung out upon the rivers of wind may fall on stony ground or be picked up by the fowls of the air. This, the old and tried way of replanting a forest, is a conservative way, and if we had a million years or so, it would probably be a good way, but it is not a quick way nor a sure way. In view of the increasing number of things that 127,000,000 Americans need, and the number of acres which have lost their trees, we do not dare to wait for it.

The Forest Service is gathering seed of forest trees. To the Rhinelander Forest Nursery, for instance, where cone-bearing trees are started, bags and bags of newly gathered cones are brought. These are ripe but have not yet opened to let the seeds fall out. They are placed in shallow trays and slid into ovens where the heat is kept considerably above that of a hot summer day. These cones, prepared to hold a pair of winged seeds, close under each little pointed cover, against cold and drought and sleet and wind, perhaps for a season, perhaps for years, till the perfect warm, dry day comes to release them, find their long task miraculously shortened and the warm, dry day they were waiting for, unexpectedly arrived. Under this delusion, they raise their rows of shell-like covers and leave the seeds free. The trays of open cones are emptied into a great revolving drum and slowly tumbled round and round till the seeds are shaken out. Then a blast of warm air blows away their wings, as a threshing machine winnows the chaff from the wheat, and the pure seed is gathered up and kept dry and cool till planting time. Long before the usual time, the seeds of these conifers are ready to grow, and the length of time before a seed can become a tree is shortened by just that much. We do not dare to wait for deliberate nature unless we must.

The time is shortened also by the care given the seedlings. We do not let them sprout unprotected. As we entrust eggs to incubators instead of to the hen—sometimes 300,000 to a single machine—and as we do not rely on what bugs and worms an incompetent mother hen may chance to scratch up for her brood, but feed them scientifically to produce the biggest, healthiest chicks in the shortest time, so we take the ticklish business of bringing up a new forest away from the parent trees.

We send the seeds to the nursery, where they are laid in soil which has the perfect ingredients to give conifers a good start. Sometimes they are sowed broadcast and come up in a thick green carpet like a well-kept lawn; sometimes they are put in with a drill and grow in a pattern of narrow green stripes with earth between; but always they are planted in bands 5 or 6 feet wide and as long as there is room in the nursery. No hungry bird can peck them out of these green beds, no squirrel or chipmunk has a chance to get them, for over the top is spread a wire netting. When the sun is dangerously hot, there are wooden gratings to shade them, when there is danger of their drying out, there is an overhead sprinkling system like those installed to prevent fires in factories—long rows of pipes 5 or 6 feet above ground, with tiny holes through which drops artificial rain.

In these nurseries the little trees grow for 1 or 2 or even 3 years, as carefully guarded from injury as though they were the Dionne quintuplets. Sometimes they are transplanted from one seedbed to another, and the taproots that grow straight down are pruned so that the trees will develop strong side roots in their place; sometimes they are transplanted as a gardener takes out the snapdragons that have come up too thick—so that each young plant will have room enough to grow.

When the time comes for them to go out into the world, the reason for the planting in long narrow bands is clear. At the end of one of these strips appear two men with a knife blade as long as the nursery bed is wide. At the two ends it fits into a swinging frame which rests on skids one on each side

of the band of trees. This machine is attached either to a gasoline motor, or to two horses. The long knife, like a straight scythe blade, is pushed down under the seedlings at the end of the row, and slowly pulled forward about 8 inches underground. Above it there rises a green wave as the trees are cut loose from their seedbed and settle back upon it again. Down one long band of seedlings and up another goes this subterranean knife till as many trees are cut loose as are to be planted that day.

Then comes a corps of forest workers—perhaps C. C. C. boys—who pick up the trees by handfuls; throw away all that have not grown as tall as they should, or have not developed good roots; and pack the others in long baskets—tops at the ends, roots in the center covered with wet moss. The trees are ready now to begin a forest of their own. The place is already prepared. If they are to go on rough ground covered with sod, the land has been "scalped", that is, the sod has been cut away and the soil left bare on 2-foot squares, 6 by 4 feet apart. If they are to be set on level ground it has been plowed in furrows 6 feet apart.

To the place for the new forest, the C. C. C. boys bring their baskets of seedlings. Each has a special planting tool in his right hand—a sort of glorified cross between a large sharp chisel and a small dull spade with a long steel handle—and in his left hand his basket of trees. They begin in a line, with the boss at one end, each boy back of the spot where he is to plant his first tree. The planting tool strikes deep into the center of the scalped square, the boy pulls it toward him, leaving a narrow wedge-shaped pit. He drops the planting tool, takes a tree from his basket and sets it in the place he has opened, pushes earth down around it and makes it firm with a foot on each side; then advances two paces to stoop and plant again, and the line of boys goes on across the land, leaving a new forest as they go.

Transplanting is in the nature of a surgical operation to trees, and sometimes they cannot survive it. All of them need time to get used to new conditions and prepare to meet new enemies. There are rabbits ready to nibble off the buds,

Starting new forests.

C. C. C. planting time.

Marking the forest for harvesting.

Log chute.

Yellow pine seed trees, New Mexico.

But what use to breed new types of trees that will shoot up at a speed never before known—what use to gather seed, and establish nurseries, and plant and prune if we do not protect forests from their enemies?

The forester must be a sort of doctor to the trees. He must understand what to do when they are sick. Disease in the forest is so common that until recently it has been taken as a matter of course. Most of the fungus diseases act slowly and their work is not evident to the casual observer, but the forester must learn to identify them in time. Other diseases spread swiftly. All the forester's efforts to produce vigorous trees in the shortest possible time, all his studies of their life processes and the factors of soil and climate and moisture, may go for nothing in the presence of such a thing as the chestnut blight which has practically eliminated the American chestnut.

Into a dining room in northern Minnesota came two anxious-eyed foresters. "How you getting on with the blister rust?", asked one.

"Bad! There's more of these currant bushes in my territory than there are rabbits—and that's some! It's hard to teach a new crew to know a currant bush after all the leaves are gone and harder yet to get all the roots up."

"Got to get them though!"

Yes, they've got to get them, for the fungus that destroys the precious white pines spends part of its life in a currant or gooseberry bush—its vacation time probably—and if there is no such bush within 900 feet of a white pine, then the tender blister rust spores die before they reach one, and the tree is safe. And so anxious men in high-laced boots appear before New England housewives:

"Madam, we're going over your land to get out the wild currant. It's to save the white pines."

Then there's the whish of busy poison sprays and a digging of roots, and sometimes a tearing down of old walls to get at obstinate shrubs—and an expert building of them up again.

It must not be forgotten that insects also attack trees and find them good to eat—root, trunk, bark, and leaf. Hosts of these hungry pests are perpetually lying in wait.

And so the forester must learn about them! There are millions of insects that feed on different parts of living trees. Most of them do little harm, but occasionally a species sweeps like a scourge through the forest, killing thousands of trees. There is no use trying to destroy insects in the forest in any sort of individual, hand-to-hand combat. It is not possible to pick them off like potato bugs one by one. The forester must learn the life history of any enemy insect, must determine when and how to hit it, and then organize a campaign on a large scale to deal with it.

These campaigns do not always succeed. For years the forest service tried in vain to save the lodgepole pine in certain gulches of Montana. This is not a large tree, but it stands many to the acre, and timbers from it are used to shore up the great copper mines of Butte and Anaconda. The trunks of millions of them, hewn into ties, have formed the beds for the railroads that cross the northern Rockies. More than 95,000,000 new ties are needed every year. But the lodgepole pine has no defense against the subtle, well organized attack of a tiny beetle not a fifth of an inch long. A few beetle scouts fly ahead of the main body and take possession of a group of sheltered, well-placed trees. The next year hosts of their relatives move in. These beetles bore in between the bark and the wood and girdle the tree more effectively than could be done with an ax. A long, extraordinarily cold winter will freeze many of these beetles under the bark. If it is cold and wet at the time when the newly hatched beetles are ready to fly many are killed. But neither weather nor man has been able to win this fight.

In the Montezuma National Forest grows the ponderosa pine. This forest covers a broad high mesa in southwestern Colorado, and in 1910 a few Black Hills beetles were found there. The forest ranger reported that they need not cause serious alarm though they would "bear careful watching." During the following 20 years those beetles, having been

lumber and no money to start the fight, so the Black Hills beetles kept on boring into the trees, laying their eggs, bringing up their offspring, and killing the ponderosa pines in peace.

But 1933 brought the C. C. C. Here were workers to fight that prolific beetle. Those husky young men cut down those infested trees and burned them or peeled the bark in which the eggs were hatching from the trunks and burned it, together with the limbs where the beetles lived before they were ready to fly. During 1933, 1934, and 1935 this fight went on. Occasionally the tide of battle turned against the trees, and there were more beetles; then it swung the other way, and there were fewer beetles and healthier trees. By the middle of June 1936, 20,084 trees had been cut, stripped, and the bark and the limbs burned, and the report came "The project appears to be completed."

Sometimes it is possible to fight one insect with another. There was, for example, the strange case of the ponderosa pine which was brought into Nebraska to help hold the shifting sand in place on the western hills. It was no sooner established than there appeared an insect called the Nantucket tip moth, which attacked it with disastrous results. This moth had made its slow way through the northern forests from the eastern island from which it took its name. Had the Nantucket tip moth an enemy? The scientists began to hunt for one. It was necessary to find an insect which would attack the larva of the tip moth at the moment when it was defenseless. Insects were imported from the four corners of the earth, but none were ready at the critical moment. At last there was brought in a wasplike insect from Virginia. The timing was perfect! The wasp killed the larva of the moth. But then a disconcerting thing developed. Another pine-destroying moth, which had been nearly starved out while there were plenty of Nantucket tip moths to feed upon the pines, now finding its way clear, fed itself full year after year, increased in numbers, and in its turn fell upon those ponderosa pines—and for the larva of that moth the wasp from Virginia had no appetite whatever!

FIRE!

From the time that a tree begins its life the great, overwhelming danger it has to meet is fire. Fire will roast the seed in the ground, will suck up a sapling in one great whiff. The largest and tallest and strongest tree in the forest cannot save itself when fire comes through. All that the forests might do for our comfort and prosperity and pleasure can be prevented by this bright and dangerous foe.

What is this fire?

A simple chemical reaction, the satisfaction of one of those strange cravings between the atoms of which the universe is made, the result of the irresistible affinity of oxygen for other elements. When the temperature is high enough to change some other substance into a gas, the union is readily made.

A match, an electric spark, a stroke of lightning, two sticks rubbed together, flint striking steel, a dozen other things, will create heat enough to produce fire. And to put out a fire is to throw the process into reverse, either to get rid of the oxygen, get rid of the substances with which it unites, or to so reduce the temperature that a gas cannot form. A fire can be either frozen out or smothered. Both these methods are used in controlling forest fires. Sometimes the wood and brush and leaves are removed from the path of an oncoming fire so that the oxygen will have no other elements to unite with. Sometimes the fire is smothered by throwing earth upon it, which keeps out the oxygen, and keeps down the temperature. At other times it is put out with water. Water stays as water long enough to reduce the temperature below the level at which gas is formed. It has also what is called a high ratio of volume of vapor to the volume of the liquid. That means there will be a lot of steam from a small amount of water, and steam will keep out air and smother fire. Weight for weight, water has been found the best material to subdue forest fires.

There is no way of making forests immune to this chemical reaction. Wood will burn. What we can do is to keep fires from getting started; to so manage the forests that they will not be good fuel; to have the aid of science in keeping us

highways like beads. They are strung farther apart on the foot trails and the creeks where men fish. Sometimes there are no dots except on the roads over which men travel. Fire control is a poor substitute for fire prevention.

It is hard to alter habits. A cigarette butt is uninteresting. There is really nothing in a burned match to allure and charm, but the imperative need to break it in two and insert the charred end in a pocket instead of in a pile of dry leaves on the roadside, has got to be met. To gather sticks and build a fire beside a stream, boil a pot of coffee, and broil a strip of bacon has all the joys of Davy Crockett and Robinson Crusoe combined; but to dig down afterward and lay those burned sticks in a hole, to carry water from the nearest creek in the coffeepot and soak them past any disposition to smoke, to cover them hard and fast with earth that has nothing more inflammable in it than pulverized rock, and then to stamp on the place—these processes are as dull as brushing one's teeth. But to put out fires must become a human habit if we are to enjoy the gifts which the forest can offer us.

Through one of our inventions, the steam locomotive, we start almost as many fires as through that earlier invention, the match. We send these inventions roaring through the forests, throwing sparks into the air that fall to right and left of the track. Do we have to choose between our forests and our railroads? Not if we change them both.

To alter the locomotive is a relatively simple matter. Sparks do not have to fly out of locomotive stacks. They can be kept inside, and locomotives do not have to be run by wood, or coal, or even oil, or any fuel that will throw sparks. In many cases they can be driven much better, much faster, and, in the long run, much more economically, by electricity.

Then the forests can be made much less inflammable. Fires usually start in the underbrush and the litter. The underbrush and the litter can be taken away. Railroad fires usually start near the track. There can be a wide, clear space between it and the woods.

The first requirement for controlling a fire after it is once started, is to find it. This is not so easy as it seems. There are records of fires within the last 2 years which have not

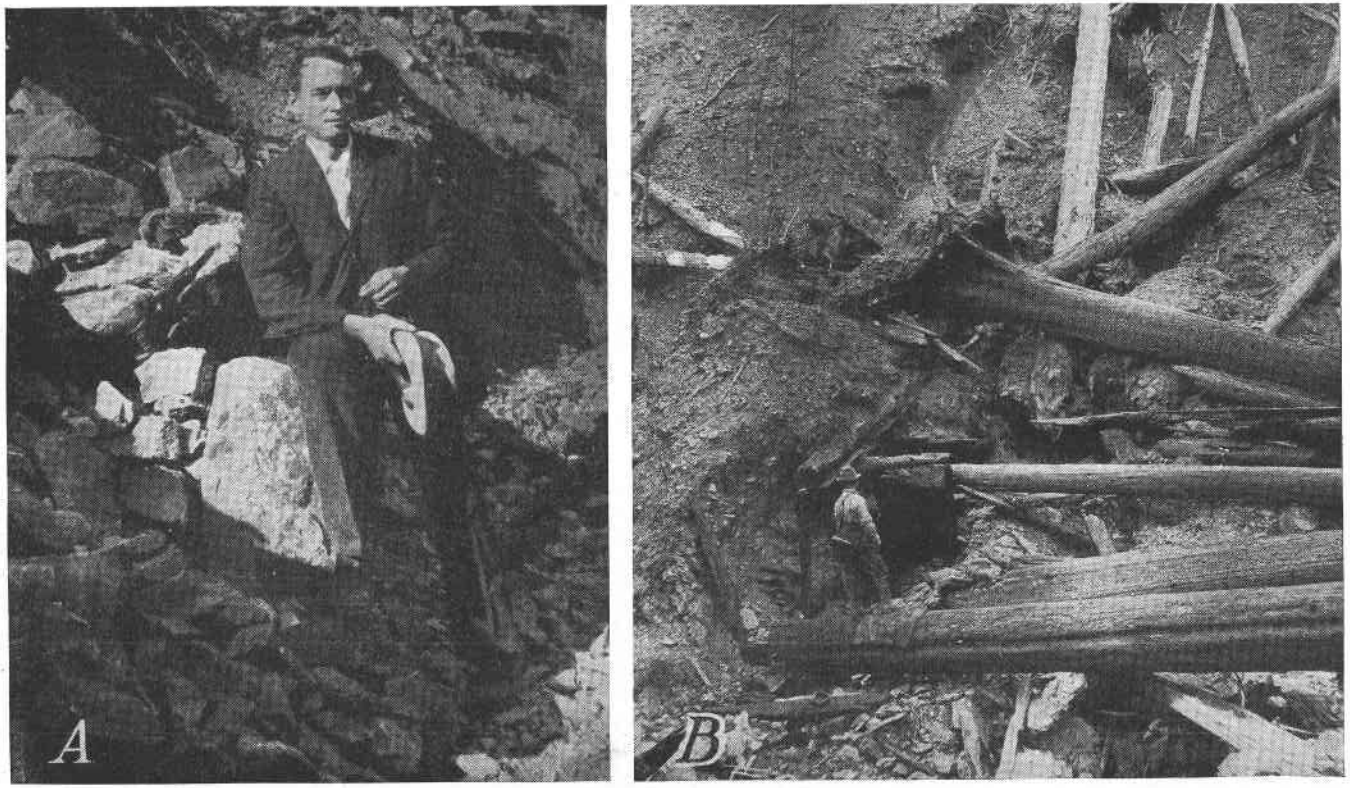
been located for more than a week, although men had seen their smoke in the sky and gone hunting for them through the woods. In order to find fires while they are still small, lookout towers are being built all through our forest country. These have an open iron frame work with stairs angling around inside or ladders going up the surface. When one is built on a high mountain top, it need not be very tall because the man in it doesn't need to be raised much from the ground in order to look across the sea of green trees below him. But when a tower is on level ground and the tall trees come close, then it must go up perhaps a hundred feet, so that the man inside can look over the top of the forest.

Up there in the singing wind he has a small room, glassed all around as though he were in a lighthouse. He has before him a map of the locality placed exactly like the country over which he is looking. As a captain finds the location of his ship with a quadrant, so the lookout locates a column of smoke by a movable bar on the map before him. The base of this bar is at the place where he is standing. He moves the far end of the bar until it points directly at the smoke, notes the position of the bar in degrees and the minutes and seconds of the same sort that are used at the observatory in Greenwich, and then telephones the direction to the nearest ranger station. Usually some other lookout in the vicinity has sighted the fire by now and telephoned in its location from his post. The ranger knows that where the air lines from two widely separated lookout towers cross is the place of the fire.

What happens after a fire is discovered and located is very different now from what it once was. The time when there was not much to do but pray for rain, particularly in the forest country of the West when the thunderheads came rolling over the mountains, is long past. It is very different from what it was only 25 years ago when the disastrous fire happened in the Coeur d'Alene National Forest in north Idaho.

Fires were raging in all directions and fire crews were fighting them 24 hours a day. It was mountainous mining country, and there were no roads over which motors could bring

Locating the fire.



(*a*) *Pulaski.* (*b*) *The cave where the men took refuge.*

till spring. The mountain streams that should have brimmed full till June showed a mere trickle when April was only half gone. If you rubbed a pinch of duff between your fingers it went to a brown powder so fine that it could drift off into the air. And the dry wind blew and blew and blew. The Plumas Forest was crisp and brittle. The sky was clear, the earth was dry, the wind was high and steady. May went by and June. In July the national forests were so dry that no one was allowed to enter without a special permit.

But August 17, with a dry wind blowing strong from the southwest, was a perfect day for a fisherman to escape from the city and climb 4,000 feet up in the mountains to try his luck along Nelson Creek. After his steep climb he would have been ready to rest, to make coffee, or perhaps light a pipe. Just what he did is not known, for the man has never been found.

Two lookout stations are within range of Nelson Creek. The first lookout reported rising smoke at exactly half past 12 and the second exactly 1 minute later. Just a minute after this, the dispatcher at the nearest forest headquarters telephoned the foreman of a C. C. C. crew of 40 men who were constructing a road, to call them together, furnish them with fire packs, load them into trucks, and start. In 23 minutes more they were on their way. Five miles by truck, 3 miles on foot, carrying their equipment, they reached the fire at 40 minutes past 2.

In the two hours and 10 minutes that fire, which had been no more than a veil of smoke blowing out above the trees when it was first seen, had gone raging up to the top of Eureka Ridge. Seven hundred and fifty acres of burning woods met those 40 men. But telephones in all directions had carried the call, and in 20 minutes 80 more fire fighters who had been rushed 18 miles by truck, arrived to reinforce them. At 5 o'clock came 240 more. There were now 360 men tearing out the underbrush, digging down to mineral soil, using bare rocky slopes and creek beds to establish a band around that fire, where the flames must die because there was nothing left to burn. Before sunset, another 100 men came in. There were now between 400 and 500 men working, and 1,500 acres were burning.

During the night of August 17 the wind calmed down, and the air was cooler. Two fire lines had gone up the hill from the base beside Nelson Creek, one on each side of the burn. They had reached the top of the ridge. It looked as though the worst was over, and the foreman sent all but eighty of the freshest men back to camp to rest. Eighty men would be able to pull the ends of the fire line together, especially since a relay of 45 more, who had been working to eradicate blister rust, were on their way. They worked the rest of the night, and shortly after daylight the ends of the line were connected beyond the top of Eureka Ridge. The fire had now covered 1,950 acres.

At 11 o'clock the wind waked up again and whipped the smouldering fire into flame. It jumped the north line and burned a narrow strip up the mountainside. The first fire line had to be abandoned and a second line run up outside of it.

At half past 1 the heavy wind took the fire over the line at two new places on the south side where it had not had time to cool.

A patrol plane had come and was now flying back and forth. It brought the news that the fire had "lit-a-running," a quarter of a mile outside the line. By dark all the men were working on new fire lines. Three thousand one hundred and twenty acres had been burned.

During the next day 360 more men came in. Some of them were from a C. C. C. camp, others were S. E. R. A. crews, and another blister rust-control group had been gathered up. The first crew, which had been sent to rest, went on duty again in the middle of the night. By sunrise the fire was again corralled. Inside the line were 3,770 acres.

The northeastern section of the fire line did not hold; and the fire came down from the crowns of the trees upon a rough, precipitous cut-over country which led down to Peoria Creek. The men made a flank attack and tied a line around it.

But at the same time that the fire died down at this point, little whirlwinds west of Poplar Creek picked it up and carried it across the line for a mile and a quarter. By dark this new fire had covered 1,600 acres, and by morning 900 acres more had been burned.

would die down for lack of fuel. But the wind was high; the main fire came on fast. The strip in front of it had not burned clean, so that a little after 1 o'clock the head of the fire carried over and burned another 1,350 acres. Again the men worked all night, and by morning on August 23 the fire was corralled inside a new line.

During the day of August 23, they had 29 miles of line under control so that men could be spared to go to the northeast of the fire where it had been alternately backing slowly downhill and then running rapidly up at a new angle. They tried to use a tractor on these lines, but the ground was too rough. Control lines were built around this by hand, but again and again the fire hurdled them, and during the afternoon it took 400 acres more.

On the 24th of August the fire jumped the line at only one point and took only 100 acres more. The wind was still strong, but the air was not so dry, and the moisture that was in it helped to control the fire.

For the next 6 days the wind was gentler, and not until the first of September did it jump a line again. Then there was a slop-over on Belle Bar Creek, but the fire picked up only 50 acres more. It had covered 10,150 acres.

After that there was the long job of mopping up. Where the crew saw smoke they pulled old stumps and branches apart so that they would not burn; they dug holes to bury clumps that could not be smothered by shovelfuls of earth. They stayed on the fire, patrolled it along the 29 miles of fire line and over the 10,150 acres which had been burned until heavy rains came in October.

Something over $50,000 in money that fire cost. But what did it cost in human comfort and prosperity and in the other things which $50,000 so poorly represent? How about the houses that can never be built now, the paper that cannot be made, the shining cloth that can never be woven, and the pleasure that hundreds of people might have taken in those 10,150 acres which are now stripped bare? Money has very little meaning set against the real cost of a forest fire.

The scenes of forest defeats are terrible places. There is no silence so terrifying as that in a burned-over forest. Living forests may be quiet, but they are full of gentle noises. The winds swing branches against each other, leaves fall, sleepy birds talk back and forth, squirrels rustle about. The desert has the perpetual murmur of soft shifting sands. Even a mile underground in a coal mine there are quiet whisperings as though the layers of rock were moving against each other. But in a burned forest there are no seeds to drop, not one ripe leaf breaks from its branch, not one branch is left for the wind to whistle through. It is a silence produced by a great death, and it will not be broken until life comes back.

When a fire has been finally corralled, mopped up, and stamped out—when the floods have come and the rains descended and there is no smallest drift of smoke from the burned area—then the man who has led the campaign against it makes a sort of clinical report of what happened. It goes through the hands of his superior officers and finally arrives at the file in Washington. As these records proceed on their way, little comments are dropped upon their margins in red ink or blue pencil, and various degrees of praise or blame are meted out. This man might have got his men together quicker. Why did not this crew do more back-firing? Where was the tractor that should have furrowed up the smoother sections of that fire line? Few reports escape this searching criticism, for to human happiness and human prosperity, the seconds between the finding of a fire and the reporting of it are as vital as the time between the strike of a rattlesnake and the injection of the serum to counteract it. But sometimes a report comes through with the simple comment of the man highest up—"Good job."

That official comment "Good job!" is earned quite as much by the organization that the Forest Service has put back of the work as by the man who had charge of the fire. The fight is an end product; on what does it rest?

The forest ranger to whom the telephone report of a fire comes has before him the records of the amount of moisture in the litter on the forest floor. He has the latest reports on weather, including probable direction of the winds and the possibility of rain. He has maps of the locality showing every kind of road and information as to whether it is passable for motors, and a fire engine, whether it is a trail that might be followed by a horse, or just a path through the forest over which men must carry their own equipment. He knows where the canyons are that will act like chimneys under a forced draft; he knows where the fire may be expected to back slowly downhill and where it is likely to ramble over uneven ground. He knows where the streams and ponds are and whether there is water enough in them to supply the pumps.

His fire truck is ready, within a minute, to shoot out of the firehouse doors. After the fire engine go the truckloads of men, the camp equipment, food, first-aid tent, and extra tools. The cook is almost as important as the foreman. There must be lots of food and gallons and gallons of strong coffee. The food for 25 fire fighters to last 4 days will weigh 700 pounds packed, that is, 5 pounds of food per man per day, and in addition to this, tobacco.

If the ranger reaches the fire while it covers not more than a quarter of an acre—what is called a class A fire—he can see all around it and determine at exactly which spot there is the most material for it to spread on—a pile of slash, a growth of dry fern or fireweed, a steep ravine to act like a chimney—and attack it there. Then he can encircle the rest of it with a tight fire line that will hold it down.

A class B fire may cover as much as 10 acres. In a forest you cannot see all 10 acres at once. The ranger must travel around it to make his plans. If it still is a ground fire, and if he can hold it down, prevent its spreading into the treetops out of reach, where the wind can catch it and spread it—he can probably keep it in class B. He must attack it with speed—must throw a line across the way it is trying to go.

But if it has got into class C—if it has spread over more than 10 acres—then he must plan a campaign which may include seige, slow tracking and pursuit from the rear, an attempt to turn it toward some impassable barrier, a plan for which he must command his men as autocratically as the captain of a ship. And also like the captain of a ship, he must be able to rescue them in emergencies.

Only men "strong of their hands"—the first requirement for English soldiers 800 years ago—are good fire fighters; only men well shod so that their feet will not be blistered when they work on hot ground, no boys so young that they have not got their full strength, no men so old that they have lost theirs; and always men with "intestinal fortitude"—an elegant Forest Service equivalent for a very plain word.

It is not a pleasant job these men have. The minimum of work is 12 hours a day of the most strenuous sort, cutting down trees, digging fire lines down to mineral soil, grubbing

out the underbrush, sometimes in an atmosphere of terrific heat, always of smoke, and frequently of danger. There will be no bath. They will sleep on thin beds spread on the ground. It is not as though the men were sure of these 12 hours of sleep. In any emergency the gang that is resting is roused and sent to the lines again. It is a question of just how long human doggedness can hold out, for a fire fighter must stand up to a fire, as he would to a human enemy, get it down and hold it down when he is gasping with heat and choking with smoke.

To save the forests from fire, we must tame them. The domesticated forest will be a group of tall, straight-trunked trees, standing close together and holding their crowns high above a clean, moist forest floor. It will be traversed by roads and trails and paths along which men can move easily to watch and protect it. It will be held in a web of telephone wires anchoring it to lookout towers and ranger stations and centers of supplies and men. When danger from winds and drought is afoot, extra guards will be sent carrying what is far more important in the forest than guns—portable short-wave radio sets, of which the Forest Service has more than a thousand—so that danger can be reported from localities remote even from telephone lines. Everything will be organized for speed to catch a fire as near the moment it starts as possible.

But when we have trained ourselves in caution, and made our forests as nearly fireproof as possible, and established a system of fire fighting with all that experience, character, and science can give it, will there still be forest fires? Unfortunately, yes!

Until we know how to direct Jove's thunderbolts to the open sea, or bare mountain tops, or sand-covered deserts, there will be between 4,000 and 5,000 forest fires started by lightning every year. But they need not burn the 180,110 million board feet of timber which they take now. There is no reason why we should go without the houses, and railroad ties, and turpentine, and shoe soles, and fence posts, and rolling pins, and newspapers, and movie films, and boats that these 180,110 million board feet of lumber would give us; for a really civilized forest—a forest well-broken to the needs of man—will be pretty poor tinder.

THE MEN WHO WORK WITH FORESTS

The time is on the way when we will bring up our forests so well, and the trees will grow so fast and develop lumber at such an early age that year after year after year there will be a perpetual harvest. But whether this will make the men and women of our country happier or more prosperous or secure depends on how we use our crop of trees.

On the men who work with the forests depends the service we get from them. Who are these men and what do they do? How do they get their jobs? What sorts of lives do they lead? What kind of men must they be?

There are certain basic characteristics that the men who work with forests must have whether they are fire fighters hired in an emergency by the ranger, or the Chief of the Forest Service appointed by the Secretary of Agriculture. They must have the proper sort of a body to do the physical work required. They must be strong men. They must be able and willing to stick by their job no matter what it is, and, over and above all, they must have that thing known as character—a certain uprightness of intention—on which other people can count.

The men who do the hand work in the forests—the rank and file who the foresters direct—need these qualities quite as much as the professional foresters themselves. Since the establishment of the C. C. C., most of this work has been done by them. The majority of the 1,000,000 young men who saw service in the C. C. C. during its first 2 years, worked in connection with the forests. Theirs was the actual bone and muscle that put into effect the knowledge of the trained foresters.

If in spite of the dry season of 1935 fewer fires than the average for the 5 years before the C. C. C. was started burned more than 10 acres, it may have been because the C. C. C. built 8,000 miles of new roadways over which the firefighting trucks could be sped in; because they built 35,000 miles of fire lanes and firebreaks and cleared the dead trees and underbrush from 1,038,000 acres; because they took away the inflammable rubbish from 28,000 miles of roadsides where the

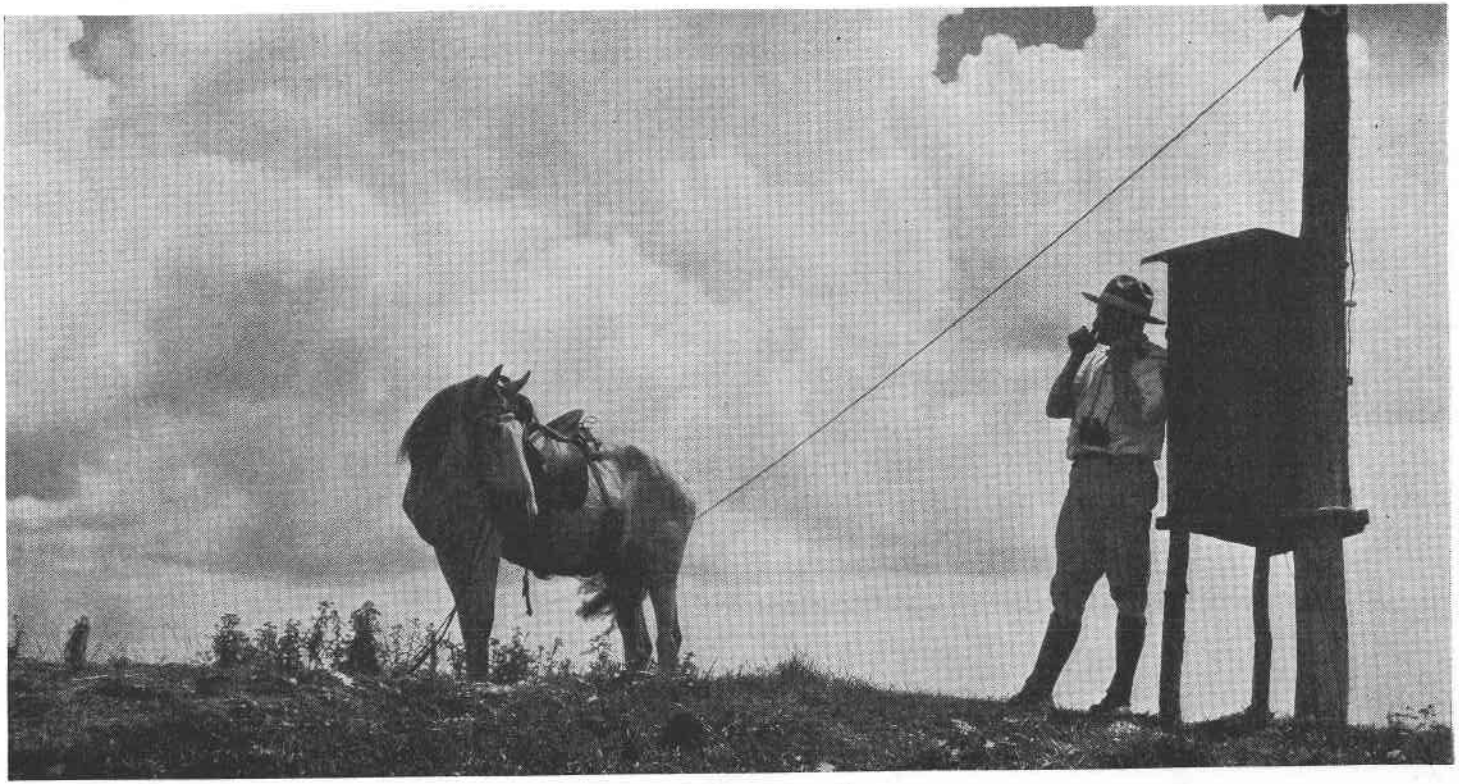
careless travelers might drop matches; and because they strung 43,000 miles of new telephone lines to connect the lookout towers with the fire stations.

This group of young men, who had learned something of forestry and had been trained to work together, saved for the rest of us a vast amount of the things which the forests can give.

They saved it in other ways besides fighting fire. They went out against the white-pine blister rust with poison sprays and with mattock and spade. They pursued the young of the gypsy moth to its cradle and committed a beneficent infanticide upon it over 4 million acres on which it had been undisturbed before. By them 267,000,000 tiny trees were started out in life.

They built bridges over streams and dug ponds for fish; they put check dams across gullies to stop the erosion of the soil and dug irrigation ditches. The list of what they did sounds like Homer's catalog of ships, and the value of it in the inadequate measure of money is over $400,000,000.

But the really important thing that the C. C. C.'s accomplished was to open a new field of public service; to show what could be done to develop our forests by putting in practice the knowledge of the scientists and the trained foresters. It has developed into an efficient understudy of the Forest Service, and with the rapid increase of the educational program in the camps, it may well become a recognized preparation for it.



Forester in North Carolina.

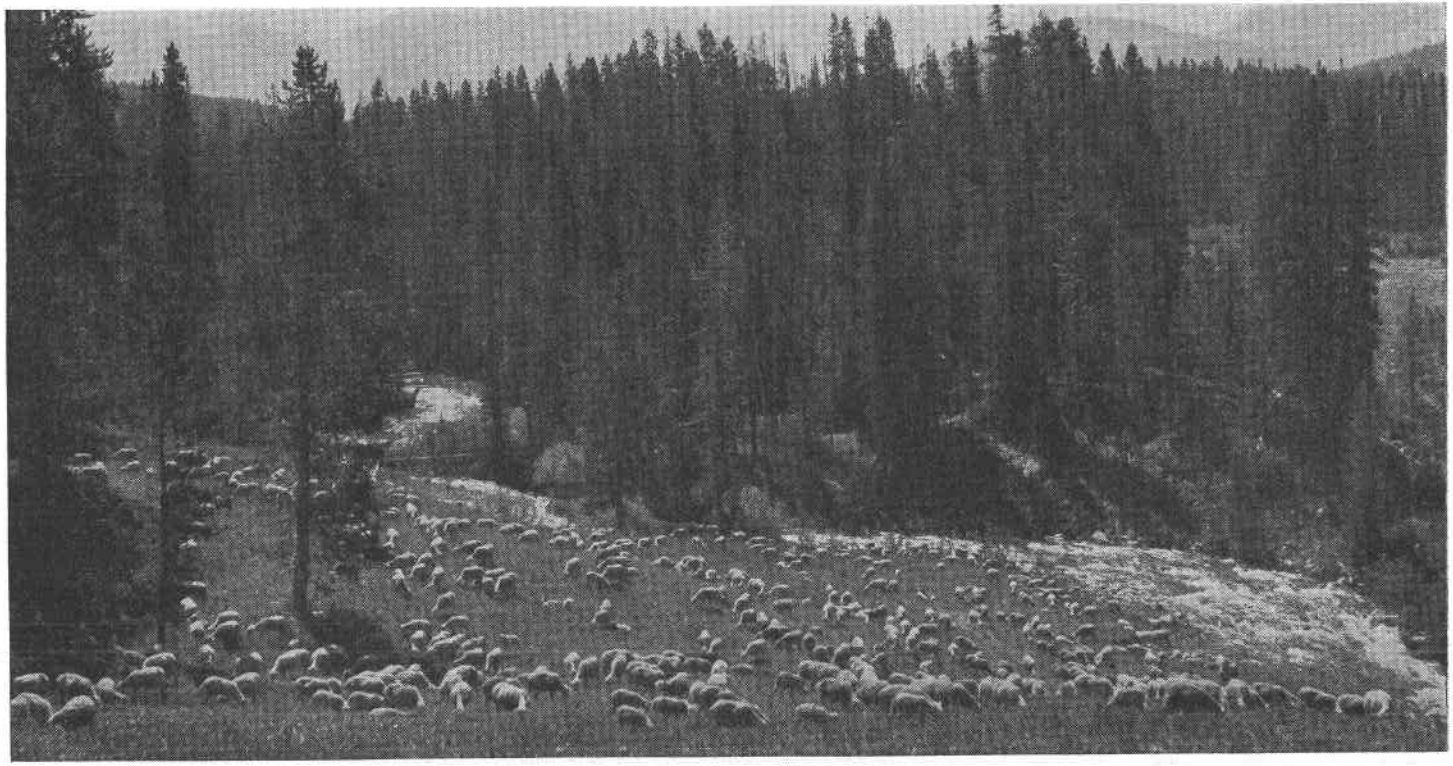
light and growing space a forest tree needs and how much water and how much and what kind of mineral food must be in the soil. He must know what this living machine that pumps up water, that creates out of light and air and water and certain chemical ingredients the root and branch and leaf and fruit without which we human beings could not inhabit the earth, is made of. What are these intricate systems of pipes and conduits, these pockets for storage, these tiny flying buttresses? What is the actual structure of bark and cambium and heartwood? How is this machine put together?

He must learn the dietetics of trees as a trained nurse learns the dietetics of children.

Seeding and planting are important phases of his study. He must understand how seeds germinate; how to plant seedlings in the field; how to encourage the seed trees in the forest to sow their own seeds. All these are part of the art of producing and tending forests in order to reap a perpetual harvest.

The forest is more than just a place to grow trees. It is among other things a cattle range. A forester must learn the principles of cattle feeding in relation to trees. What, and how much of it, does a cow eat? He must learn how to manage such things as the vast livestock ranges of Idaho. These cover great stretches of sagebrush plain which in the winter is bleak and snow-swept but in the spring blossoms into wonderful pastures. In midsummer these ranges become a dry, brown desert under the summer sun, and no grazing must be allowed until they are revived to life under the early rains of autumn. During that midsummer the forester must see to it that the cattle go higher up the mountainsides into the primitive forests where the snow is melting and the summer feed is thick under the great trees; and when winter comes, he must know that the cattle have all been withdrawn from the national-forest range where hunger would make them destroy the growing forest, and sent back to their home ranches for winter food.

After 4 years of college and the 2 years of study in a school of forestry, the gate into the United States Forest Service



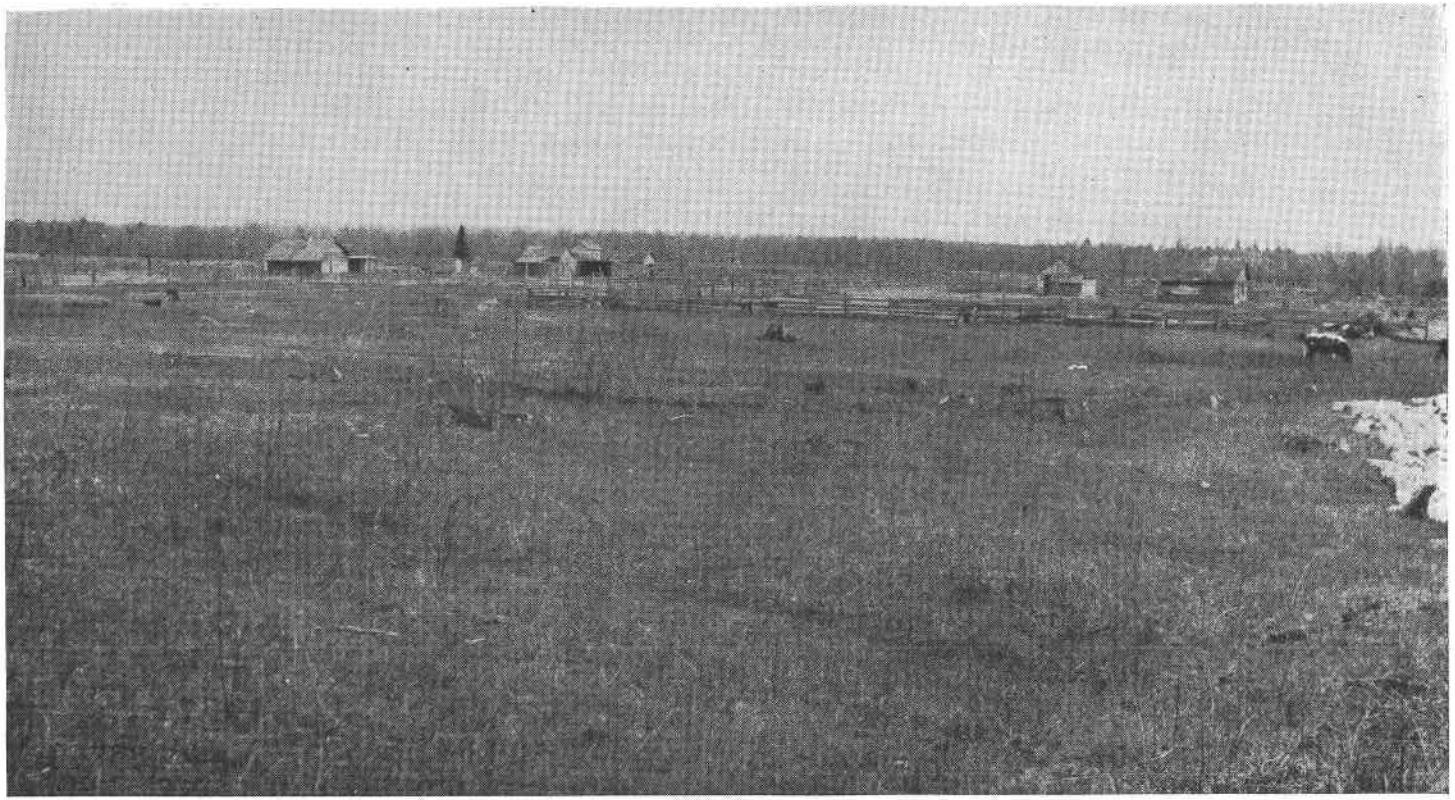
Sheep in the forest, Montana.

This problem of establishing a permanent home is one that the Forest Service is trying to solve not only for its own members, but for others who work in the woods.

Under the earlier method of lumbering—"cut-out-and-get-out"—there used to spring up lumbering towns in the center of great timber tracts. Overnight these would sprout stores and schools, churches, saloons, banks, and jails along Main Street. Perambulators would be pushed along the new sidewalks. Traveling salesmen would bring the latest thing in neckties and socks. At night, the sound of billiard balls from one side of the street would meet the sound of an organ or a college glee club from the other.

The engineer got up steam early in the sawmill, and the logs were fed in until dark. First came the nearby trees—everything cut and only the best used. The circle of cut-over land widened about the little town. Trees were brought from farther and farther away. No time to be careful that half-grown ones were not felled, that enough grown trees were left to scatter seed, that the seedlings were spared! The farmers of the Mississippi Valley were graduating from sod houses—they wanted houses of wood. There must be chairs and tables and beds and cradles in the new homes; fences about the new gardens; fuel for the new stoves. The railroads were pushing along from east to west, up from the south, down from the north, on tracks laid on wooden ties. The land was hungry for wood—the price was high—cut down the trees!

When the circle of cut-over land around a town grew so wide that it did not pay to drag logs across it, then the mill gathered itself up and moved on to another untouched timber tract. After it followed the engineers and firemen, and the lumberjacks, and the sawyers and the buckers, and all the men who had worked in the town. There were few people left to buy goods at the store; few children to go to the school; the church pews were empty; and no one had wages to deposit in the bank. No one repaired the sidewalks; no one mended the road. The only letters that went out through the post office were appeals for help to get away.



Ghost town, Michigan.

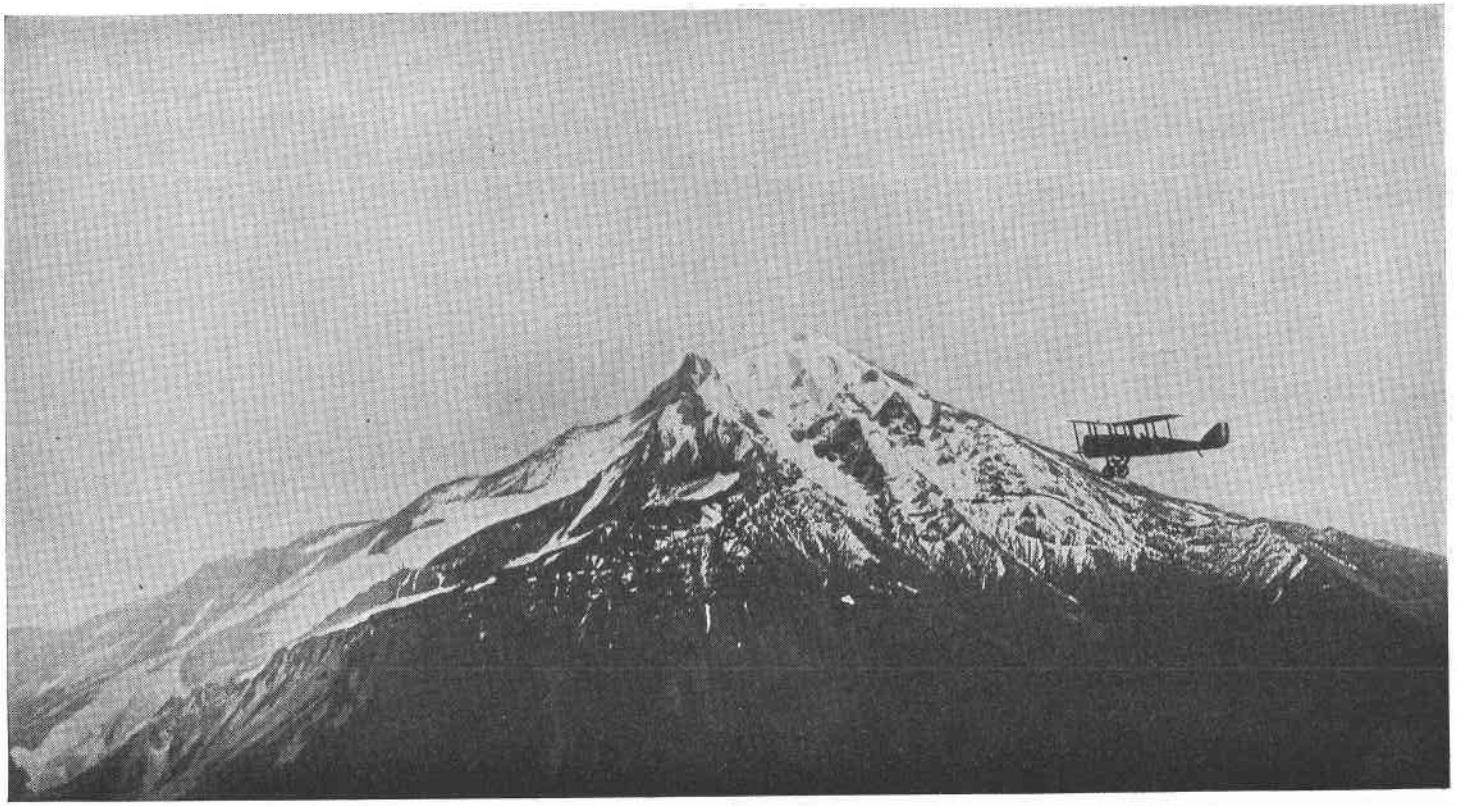
THE NEXT HUNDRED YEARS

When the end of this century comes there may possibly be a regular service by balloon up into the stratosphere. If we look over the edge of our gondola, what will we see?

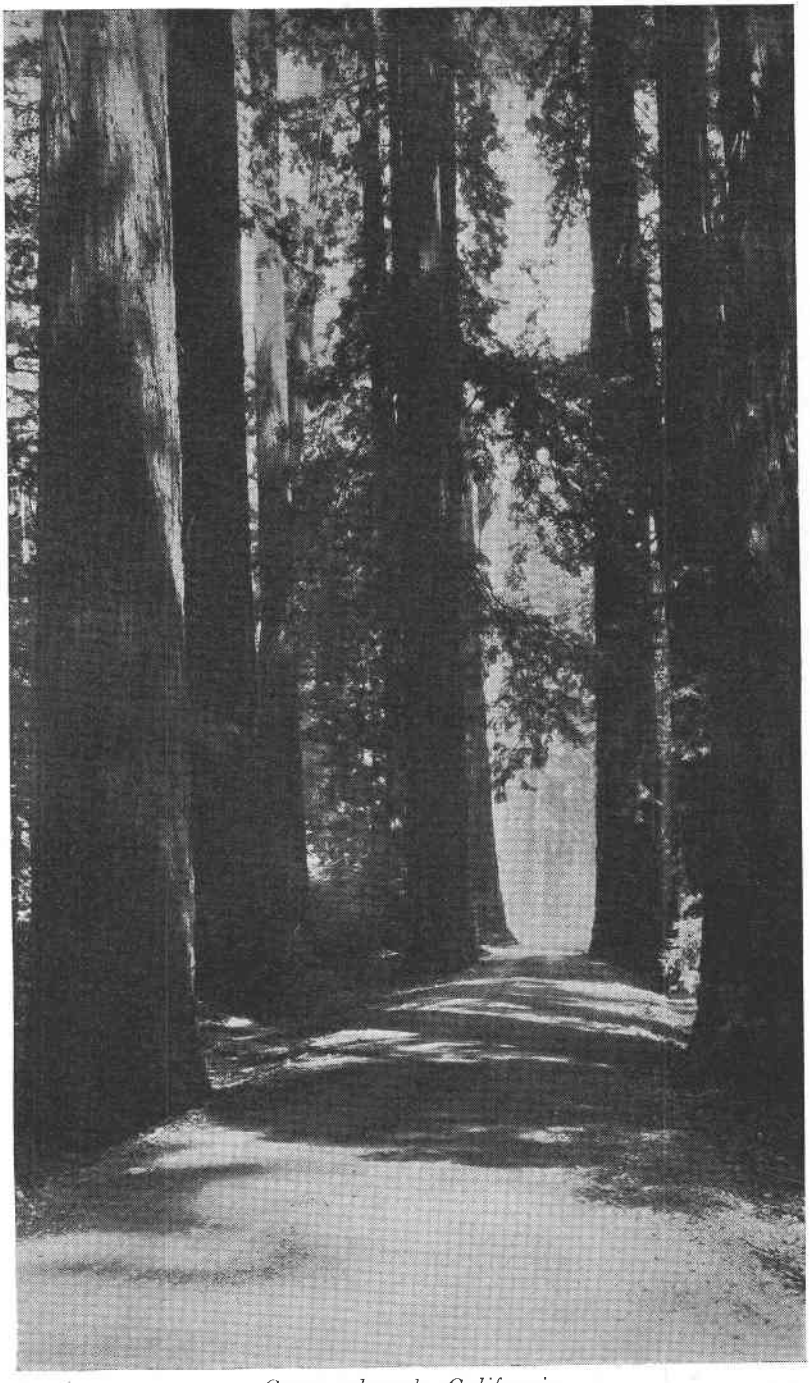
One-third of the map below us will be green with treetops. From the snow line down all the steep mountainsides, the trees will be clinging like moss. The Great Lakes will flash the light back at us like mirrors; and the little lakes will look like spangles against the green velvet of the trees that surround them. The great bowl of the Mississippi Valley will be fringed with forests, and across it will stretch the fluttering band of the shelterbelt, with the space between it and the Rockies covered again with grass as it was a hundred years ago, but pastured now by cattle and sheep instead of by antelope and buffalo. There will be places where instead of the level surface of the tamed forests, a few great trees will lift ragged crowns above an undergrowth of saplings and brush—wild forests left to show what sort of communities trees established for themselves before man became a part of their environment. If we send our gondola down close above one of these primitive areas we may see gray cougars and bobcats and lynx snarling at the hungry timber wolves, and keeping a sharp lookout for any unwary deer or elk or moose which may have strayed in.

But when a gentle breeze carries our gondola over a domesticated forest, we will see men moving about through the even stands of straight, strong trees. They will be cutting those ready to market and hauling them to a permanent mill in the center of a permanent forest city which will not be far away. Out of these forest cities will be coming trainloads, not of logs, so heavy and wasteful to transport, but of the things that are made from wood, from rolling pins to newsprint paper—finished products going straight to market.

At night these little towns will glitter up at us because they will be hung with electric lights like perennial Christmas trees, for there will be an electric plant where a dam holds back the water of the nearest little river to give them cheap power. All during the season of melting snows and full streams the



The patrol plane.



Coast redwoods, California.

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