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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

Volume 2 Number 1

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FIRE CONTROL

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The value of this publication will be determined by what Forest Service officers, State forestry workers, and private operators contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, personnel management, training, fire-fighting methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Fire Control Notes

THE FIELD OF FOREST-FIRE PROTECTION

John R. Curry

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Exchange of ideas, even between good thinkers, is almost impossible unless there is a common fund of terms which mean the same thing to those concerned. The protection of forests from fire, like other growing fields of thought, suffers acutely from lack of precision in the words and ideas used. The author boldly attacks this evil and offers some constructive suggestions. It is hoped that others will follow.

Progress and expression in any field of endeavor may be advanced through definition of the scope of the field and through development of a concise and adequate terminology. Opportunities exist in the expanding field of forest protection for the improvement of terminology and for definition of the field.

Forest-protection activities were largely neglected in the 1917 report of the committee on forest terminology, Society of American Foresters. Although forest protection is recognized as one of the five main branches of forestry, neither the term *forest protection* nor any of its accepted subdivisions are defined in the report.

The purpose of this article is to attempt to clarify definitions and interrelationships in one subdivision of forest protection—fire. The fire glossary defines *fire control* as "the entire group of activities including prevention, presuppression, and suppression, aiming to reduce the number of fires and their spread, and to confine the area burned to an acceptable minimum at the lowest possible cost. See prevention, presuppression, fire suppression." *Fire protection* is defined as synonymous with fire control, the latter being given preference. The administrative organization of the Forest Service uses the term *fire control* in referring to the entire field of fire work. Other administrative fire organizations, State and private, also commonly refer to their field of activity as *fire control.*

Although fire control as defined is an appropriate term, it is not sufficiently inclusive for all phases of fire work. Certain activities, essential to the advancement of fire control, are eliminated by the definition. Studies of fire damage, for instance, cannot be easily fitted into the definition of control as given. Likewise studies of fire behavior and of the theory of forest protection and forest-fire insurance are not directly concerned with control as defined. In forest entomology studies of pest behavior and pest damage precede the development of control practice. Likewise in fire protection, information on fire behavior and damage are fundamental to the development of adequate control.

It is apparent that some all-inclusive term is needed covering not only the activities of prevention, presuppression, and suppression, included under the general head *fire control*, but also such aspects of fire protection work as behavior, damage, and economic considerations. Gisborne has suggested the use of *forest pyrology* as an inclusive term comparable to forest entomology and forest pathology. Although it has much to recommend it, the term has not been widely adopted. In the common terminology, *fire protection* appears as the only term

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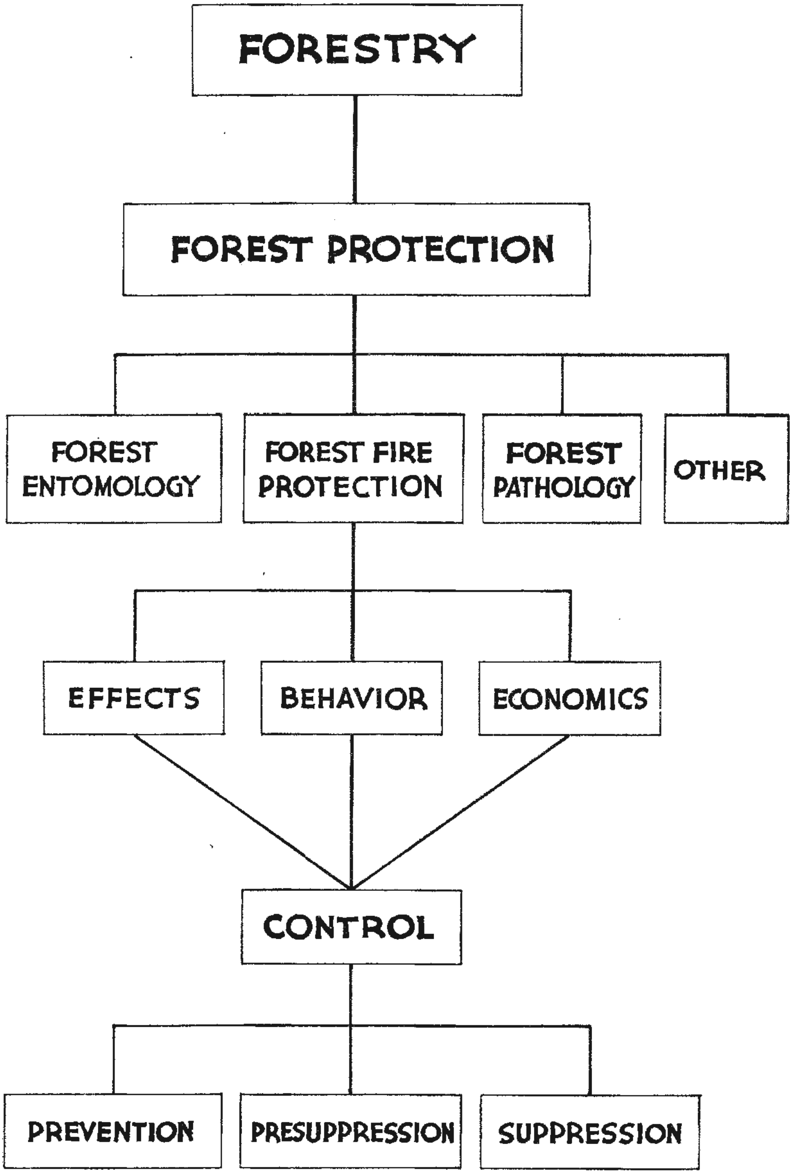

adaptable. Although it has been assailed as ambiguous, there is actually little need for concern over misunderstandings in its use, and precedent is provided by the universal practice of describing the general field of urban fire prevention and suppression as fire protection.

In this treatment of the field of forest-fire work the suggestion is made to retain for the term *fire control* the present glossary definition and to provide for the term *fire protection* a more general definition to include not only strictly control activities but also fire damage, fire behavior, and fire economics.

A suggested general classification of forest-fire activities is shown in chart 1. Forest-fire protection is here divided into four main phases—control, effects, behavior, and economics. The last three are considered to be the background and scientific phases, drawn upon by the control phase for information applicable to the fields of prevention, presuppression, and suppression. Although all work in fire protection is concerned with control, some phases are fundamental to fire control, and not part of it.

In charts 2 to 7 the various subdivisions of chart 1 are shown separately, subdivided into component parts. The conception of a

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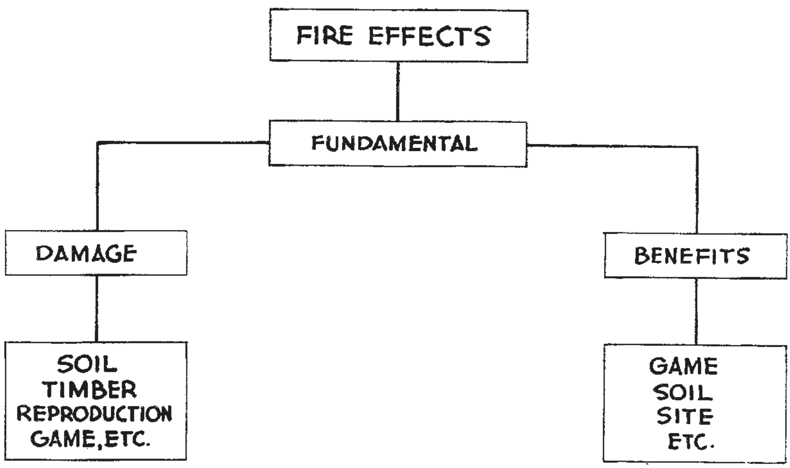

field of study designated as fire effects consisting of investigations of both the damage and benefits accruing from fire was apparently developed and used first at the Southern Forest Experiment Station. Although the outstanding effect of fire on forests is damage, certain benefits may follow many fires. A fundamental subdivision is provided for certain phases of the study of fire effects which may apply to both damage and benefits, such as the classification of fires by intensity, or the classification of tree species by their fire resistance.

Fire behavior is divided in chart 3 into four groups of studies, designated fundamental, ignition, rate of spread, and miscellaneous phenomena. This classification assumes that foresters are principally interested in the two phases of forest-fire behavior, ignition and spread. Other miscellaneous fire phenomena, such as crowning and spotting, are segregated for separate study. Because some studies in fire behavior apply to the whole field rather than to any particular phase, a section is provided to include studies of the chemical and physical properties of forest fuels, classification of fuels, fuel moisture and weather relationships, and others similar.

A section on economics is shown in chart 1 to cover such phases of fire work as consideration of costs and benefits of fire control, general

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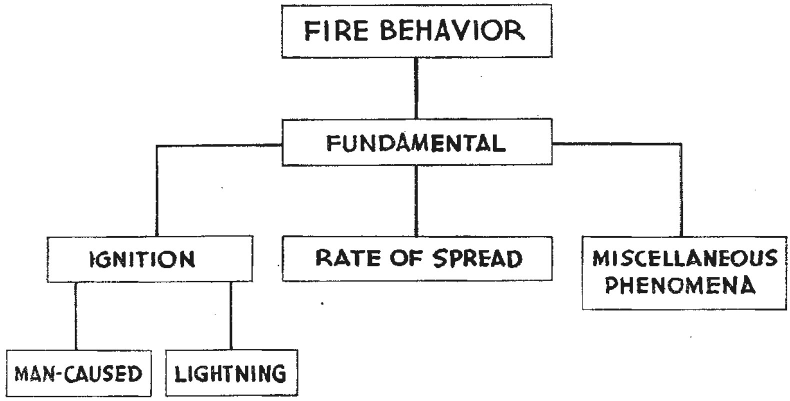

forest-fire statistics, theory of fire control, and fire insurance. It may be argued that these phases are more properly classified under forest economics than under forest-fire protection. It appears, however, that any well-rounded field of attack on fire-protection problems must consider phases of the problems listed here under the general head

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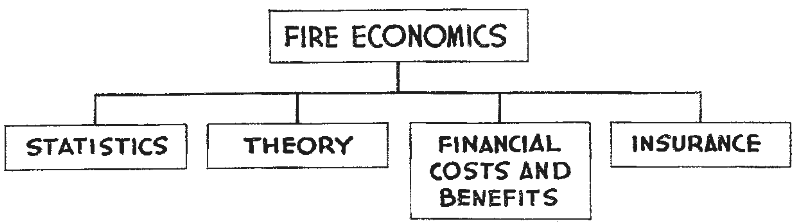

"economics." In chart 4 fire economics is broken into statistics, theory, insurance, and financial costs and benefits.

The first division under control is prevention. It is subdivided in chart 5 into two main phases, the reduction of risk and the reduction

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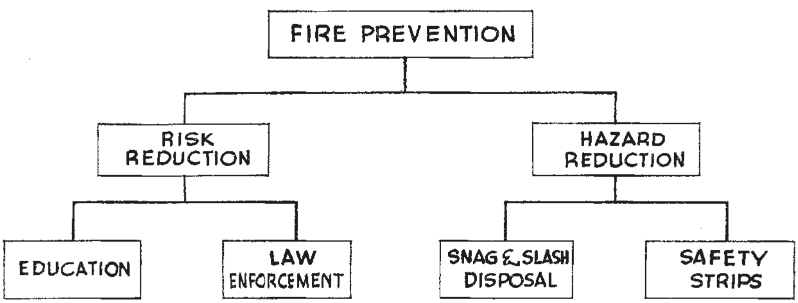

of hazard. The terms *risk* and *hazard* are here used as defined in the fire glossary, risk reduction referring to efforts in diminishing man-caused fires, while hazard reduction refers to efforts to lessen the chances of fires starting through the removal of dangerous fuels.

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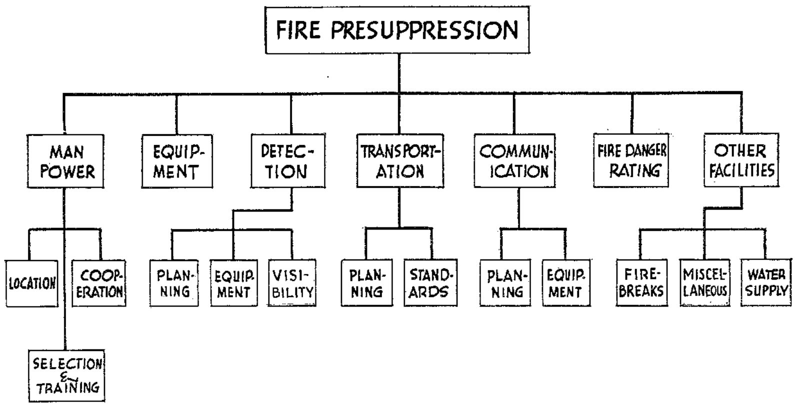

The broad field of presuppression is subdivided into seven main activities—manpower, equipment, detection, transportation, communication, fire-danger rating, and other facilities. Manpower is given a separate heading because of the importance which the location, selection, and training of personnel have on fire prevention and suppression activities. Detection, transportation, and communication are recognized phases of presuppression. Fire-danger rating, although primarily concerned with fire-behavior data, is an application activity and is properly classified under presuppression. Other facilities include firebreaks and water supply.

Suppression in chart 7 is subdivided into organization, strategy and

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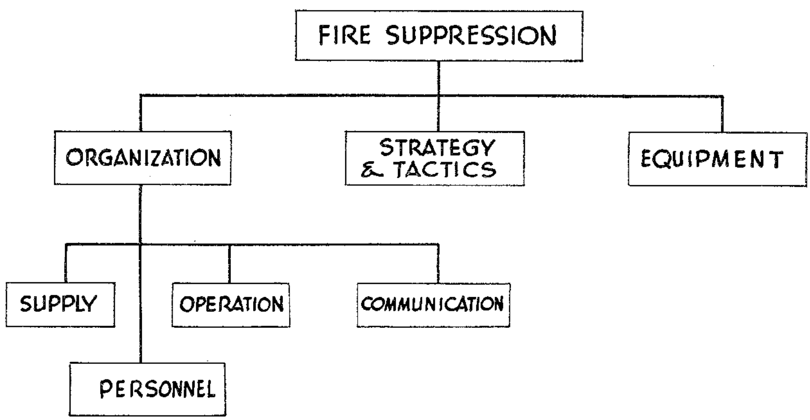

tactics, and equipment. The subdivision scheme used under organization is based upon Army staff practice.

One important phase of present-day protection not shown in this diagram is that of fire-weather forecasting. This has been considered the field of the meteorologist rather than of the forester. Certain phases of this field have, however, been studied by foresters, notably atmospheric visibility measurement.

No claim of originality is made in the organization of the fire field shown. It follows, in the main, established ideas. Foresters engaged in fire-protection work, whether research or administration, have generally agreed on broad objectives and have worked consistently toward a single goal. In the interest of progress and expression, clear definition of the field is to be encouraged. Committee action on the basis of suggestions received from foresters engaged in fire work will perhaps furnish the best means to this end.

Protection of fire-finder maps.—Often in the use of the Bosworth fire finder the map becomes wrinkled and soiled. The following measures will eliminate this trouble:

1. Remove the present map from the fire-finder plate.
2. Thoroughly clean the plate of all materials that would tend to make the surface rough.
3. Remove the azimuth circle.
4. Take a map for the lookout location that is large enough to cover the entire plate and lay it over the plate with the center pin cutting through the lookout station on the map.
5. Replace the azimuth circle, being careful to replace it correctly with respect to the false meridian down through the lookout location. Tighten up the screws on the azimuth circle.
6. Using a sharp knife trim off the edge of the map extending beyond the outer edge of the azimuth circle.
7. Measure the inner diameter of the azimuth circle, reduce this diameter by one-sixteenth inch.
8. Have a circle of double-strength glass cut to the dimensions given. Bevel the edge of this glass circle to eliminate danger of cuts.
9. Retract the center pin from the fire-finder plate.
10. Lay the circle of double-strength glass inside the azimuth circle.

Osborne fire finders may be fixed up with a glass covering for the map in about the same manner, though the job is more difficult than with the Bosworth. The center pin cannot be retracted in Osborne fire finders, hence a hole must be drilled through the center of the glass circle.—C. A. Gustafson, Assistant Chief, Fire Control, Region 5.

ARE WE LOSING OUR COOPERATORS?

JOHN D. GUTHRIE, *General Inspector, Civilian Conservation Corps*

It is no new thing, this worry about the position in which the fire-control organization would be placed with a sudden withdrawal of Civilian Conservation Corps assistance. There is only one answer—the author gives it.

Time was, before the coming of the Civilian Conservation Corps when nearly every national forest had a dependable group of local fire cooperators. Included were local settlers, ranchers, stockmen, merchants, dude ranchers, or members of the local American Legion post. They were organized, knew what they were to do when a forest fire occurred, and in many cases did not wait to be called. When word came of a fire, they went to it. Often they put out a fire, then reported it to the ranger. These fire cooperators were valuable in proportion to their interest and to the degree with which they had been organized, given some training, and were equipped. They were often our third, many times our second, and sometimes our first line of fire defense.

I wonder, if generally speaking, one finds many of these fire cooperators on the fire line these days? Have we been calling on them and using them during the last 3 or 4 years as we used to? If they are not found on national forest and State forest fires nowadays, who is fighting our fires? The answer is easy—the Civilian Conservation Corps.

I was on a western forest last summer which had once built up a fine cooperative spirit in its local people. Dude ranchers used to turn out, with men and pack stock, the local Legion post was organized into eight squads of eight men each to fight forest fires. This was no paper organization; they turned out, they went to fires, and they fought fires. Last summer that forest had a big fire when fire fighters, pack stock, saddle stock, and help were needed, and needed right then. Did the one-time fire cooperators turn out? No, they didn't. Nobody refused, but many former willing workers were out of town, or tied up, or pack and saddle stock was over the mountain.

What had happened? Again the answer is easy. Since 1933, when the Civilian Conservation Corps came, this forest had formed the habit of calling on enrollees to go to fires. They were bunched in camps and could be reached easily. The boys weren't afraid to work, were organized, with chuck, tools, and equipment, and had experienced foremen with them. It was the most natural thing in the world to call on the three-C lads. And so the Civilian Conservation Corps has been called and has been fighting our forest fires during the last 4 years, and somehow we have just about forgotten about our good cooperators. The local folks sort of passed out of the picture. We haven't been contacting them, we haven't been calling on them, and they haven't been helping on fires.

The incident referred to on that western forest is not an isolated case; I found much the same situation in the Lake States. I venture to say that it has been going on in every national and every State forest which has had a Civilian Conservation Corps camp. The enrollees have become our first, second, and third lines of fire defense, which was never intended in the beginning.

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The original idea or plan was that the Civilian Conservation Corps would be called only in *emergencies.* That is, if we had exhausted our regular protective force, local help, hired help, and local cooperators, and still needed fire fighters, why we would call on the Civilian Conservation Corps boys. But we long ago got away from that, and went further and used the enrollees for detection as well, on patrol, as checkers-in, and almost anywhere and everywhere in the fire game. All of which wasn't according to Hoyle at all.

Now if we were certain that the Civilian Conservation Corps would be with us permanently, our system might work permanently, but we are *not* so certain. In fact, on June 28, 1937, the Civilian Conservation Corps had its life extended to 1940 only. No one knows whether it will be continued after that or not; no one knows positively whether it will last until 1940. What would happen, where would forest protection be if we should wake up some morning, say next July 1, and find no Civilian Conservation Corps? Such a thing could happen.

All of which leads to the question: Wouldn't it be part of wisdom and good fire planning to rediscover our lost cooperators?

* * * * * * *

The tallmeter.—State Forester Fred B. Merrill, of Mississippi, seems to have coined a new word. More to the point, he has distributed throughout the areas under his control a most ingenious device for carrying the fire-prevention message. It is known as a "Tallmeter" because it registers the height of an individual. It is a piece of good quality cardboard, measuring 3 inches wide by about 30 inches long, and is graduated in quarter inches. At each inch mark the height is noted in feet and inches, and just above each inch mark there is a single clear-cut phrase. The following are examples: "Better fishing", "finer recreation," "food for game," "clear streams," "more forest industries," "less flood damage," "more employment," "less soil erosion." At the bottom of the strip there is a heavy line on which is noted: "Place this line exactly 46 inches above floor." Just below this is the statement: "To you who help reforestation through forest fire prevention the compliments of the Mississippi Forestry Commission."

About the use of this strip Mr. Merrill states: "We have just sent out to the counties 2,000 of these Tallmeters which cost $24.50. Our idea is that the Tallmeter will find a place in schools, doctors' offices, and public buildings, and that it will replace the more expensive calendars or similar hanging devices which are designed to stay in place for some time. In the schools I visualize the teachers of certain classes asking their pupils to prepare essays expanding on the slogan corresponding to the height of each pupil."

The idea looks good and we hope to have a later report of results from Mr. Merrill.—Division of Fire Control, Washington, D. C.

* * * * * * *

Prescott Has Good Fire Prevention Idea.—The Prescott National Forest has had the following sign conspicuously placed in stores selling tobacco, located near that forest: "We Sell Smokes For You To Enjoy—Enjoy Them Carefully and Protect Our Forests."

It is believed that by this method fire protection can be directly impressed on smokers, and many living on or near the forest can be reached who do not ordinarily read the newspapers.

EVALUATING FIRE LOOKOUTS AND DEVELOPING A FIRE-DETECTION SYSTEM

A. A. Brown and W. W. Lobdell

Region 2, Forest Service

The degree to which a forest fire lookout can contribute to the success of fire control depends on three things: (1) The amount of territory that can be seen from the lookout; (2) the potential size and difficulty of the individual fire-control job throughout the territory; and (3) the probable number of jobs or the number of fires likely to start there.

Under certain circumstances any one of these three factors may be used locally to measure comparative detection value. But where all three vary widely in the territory concerned, each must be taken into account before any conclusive comparison can be made between the value of one lookout in one part of a region against another in a different area.

Under Region 2 conditions, the necessity for lookouts is not clearly defined and only a relatively small number of primary points is contemplated. It is therefore desirable to weigh each factor carefully and to measure detection values by a combined measuring stick based on all three in order that the piecemeal approval of lookout development plans can be made with confidence by the Regional Forester.

The visible-area map shows the amount of territory to which an individual point can give detection service. The fire-occurrence map provides a basis for estimating the number of fires to be expected in that territory, and the fuel map supplies the means of estimating the job that each fire will represent.

The method used in recent work takes advantage of each of these sources of data. Though otherwise similar to methods used in other regions, it is described in some detail, particularly as it relates to the use of fuel-type data, in order to outline the procedure as a whole and in chronological order.

The first step is a thorough field investigation of all points that show any promise of having fire-detection value and the development of visible-area maps from the best of them. Following this work, or simultaneous with it, a systematic field survey of forest fuels is made and the resulting classification is identified on a map both by fuel class and by timber type. These two field projects provide two of the essential means of measuring detection values.

Office compilations which contribute data for the third consist of the fire-occurrence map and the burned-area map which are available from the records of fire history.

The procedure by which each of the three factors is then brought to bear on the final selection of lookouts is discussed in order.

The Fuel-Type Map

The fuel-type map used in region 2 was developed in accordance with Hornby's rating scheme and presents a two-way classification of the forest fuels. Each fuel is classified (1) on the basis of the rate at which it will carry fire and (2) on the basis of the work required to control a fire in that fuel per chain of held fire line. Both classifications are based on "average worst" burning conditions; that is, the worst condition during the average year. The probable rate of spread for each fuel is indicated by L, M, or H, depending on whether it is classed as low, medium, or high. The resistance to control is indicated in the same way. These two symbols are then shown side by side, thus, LL, LM, MH, HH, etc., with the rate of spread always given first. To make the picture more complete, each forest type has been assigned a number and each number is further explained by adding an a, b, c, etc., to signify a cutover, reproduction, thinned, or uneven-aged stand. Thus, the forest type symbol 1a stands for lodgepole cutover; 2b, spruce reproduction; 3, grass, etc. The forest-type symbol always precedes the fuel symbol, so for a lodgepole cutover stand, with medium rate of spread and high resistance to control, the complete symbol would be 1a–MH. The discussion of fuel-type maps is more completely covered in the Instructions for Fuel-Type Mapping in Region 2," dated January 28, 1938, issued by the regional office in Denver.

"Resistance to control" represents the number of chains of fire line per man-hour which can be built and held by a 1- to 5-man crew in each fuel type. Based on statistical data compiled by Hornby in Region 1, rates of held line production of 3.2, 1.6, and 0.8 chains were assigned, respectively, to the low, medium, and high resistance to control ratings. From statistical analysis of fire reports in Region 2, it was found that 4, 8, and 12 chains of fire perimeter at the end of the first hour of burning represented best the low, medium, and high rates of spread.

It was necessary to combine both of these factors into a single numerical weight in order that these variations in fuels might be taken into account in determining detection values. This was accomplished by dividing the rate of spread by the resistance to control. In the case of a lodgepole cut-over area which would be designated as 1a on the fuel map and which, for example, has a fuel rating of MH, the probable fire perimeter at the end of 1 hour is 8 chains and the rate of work in building fire line is only 0.8 chains per man-hour. Dividing 8 by 0.8 gives a fuel weight of 10. This figure is the potential size of the corral job in man-hours for that particular fuel combination 1 hour after the fire starts. Though the values given may be high or low for Region 2 conditions, it is assumed that their ratio is fairly dependable and that this fuel weight of 10 for an MH rating, compared to the fuel weight for an LM rating which would be 4÷1.6 or 2.5 represents a fire-control job at the end of the first hour of burning requiring four times as many man-hours for corral as the fire in the LM class of fuel. On this assumption, proportionate weights were computed and assigned to each of the nine combinations of fuel ratings used. These weights will be discussed further.

The Fire-Occurrence Map

The fire-occurrence map or "risk map" is compiled from the fire records. The location of the starting point of all man-caused fires for the last 10-year period and all lightning fires for the last 20-year period is platted on a topographic base. A 10-year lightning fire period frequently shows too little trend to isolate satisfactorily. For this reason a 20-year period is used and each fire is given only half weight, thereby reducing the lightning occurrence to a 10-year period comparable to man-caused fires. The grouping of these fires is then studied, those arising from a temporary risk which no longer exists being excluded. A boundary is drawn around each group which apparently arises from a common local cause, such as a railroad, highway, campground, etc. The number of starts within each boundary is then tabulated, together with the planimetered area of that tract. The fire occurrence per 1,000 acres per 10-year period is thus obtained for each tract and these values are grouped in a statistical array. A suitable class interval is selected and the tracts segregated into these classes. The average figure for each class is used as the weight of all tracts falling within that class, and each tract is colored on the map according to its class or "zone" weight, e. g., zone 1, white (no color); zone 2, green; zone 3, orange, etc. The average number of fires per 1,000 acres per 10-year period for Region 2 is 0.15, and this was set up as an arbitrary weight for the uncolored zone, or zone 1, on each forest.

The importance of certain high-risk areas often may be emphasized by referring to the burned-area map. The shape, size, and number of large burns may indicate extreme wind or weather conditions, inaccessibility, or some other pertinent fact not brought out by the risk or fuel maps alone.

The Fire-Danger Map

The fire-danger map is a combination of the fuel-type and the fire-occurrence maps. It is made up in the form of a tracing on the same scale as the visible-area maps. On it are shown the fuel types with the rate of spread and resistance to control shown for each area, and also the fire-occurrence zones which are colored according to their weights. The fuel ratings give the potential amount of work per fire, the risk rating gives the probable number of fires. Together they give a good measure of the fire business to be expected. Accordingly, the weight of any given acre on this map is found by multiplying the "fuel weight" by the "risk weight." Thus, if risk zone 2 had a liability of occurrence weight of 1.5, and the acre selected fell in an MH fuel type within this zone, the weight of that acre would be 10.0 by 1.5, or 15. Another acre might be classed as an LL fuel having a fuel weight of 1.9, and fall in risk zone 1 with a weight of 0.15. This acre would then have a weight of 1.9 by 0.15, or, roughly, about 0.30. It would be roughly 45 times as important to see the first acre as it would the second.

Using this map as a base, the value of any lookout can be expressed in terms of the probable number of man-hours of fire fighting required to corral the fires occuring upon any given acre seen. The unit of measurement for each lookout point then becomes the "weighted acre" and the term applied to this is the fire-danger unit, abbreviated "Du." Mathematically, the fire-danger unit may be developed as follows:

Let P=Planimeter reading.
R=Risk weight.
F=Fuel weight.
Du=Fire-danger unit.

Then, for a ½-inch scale map:

$$Du = P \times 4 \times 640 \times R \times F \div 1{,}000.$$
$$= P\ R\ F \times 2{,}560 \div 1{,}000.$$
$$= 2.56\ P\ R\ F.$$

Method of Selecting the Lookout System

The next step is to make a tracing on vellum of each visible-area map. When this is done, each tracing is orientated on the fire-danger map and all fuel and risk zones covered by the seen area are lightly traced on the vellum. It is simpler to write in on the vellum the weight of each area as it is traced. The area of each weight is then obtained by planimetering and the sum×2.56 is the *Du* value of the point. Areas beyond 15 miles from the point are not included, though territory between 15 and 20 miles is credited to the point in certain localities. On forests where only one or two lookouts can be justified, seen area out to 30 miles is sometimes shown but does not enter into the *Du* value for the point. Barren and true alpine country is separately identified and not included in the *Du* value.

When each point is thus evaluated, the maps are listed in order of their descending gross value. The one with the highest *Du* value is chosen as lookout No. 1. Each of the remaining tracings is then placed over the No. 1 tracing and all overlap is subtracted. The *Du* values thus derived are then arranged in the new order of descending value, with the highest ranking point as lookout No. 2. Again each remaining tracing is made to compete for the unseen area, and this time the net area seen by No. 1 and No. 2 is subtracted. The highest ranking point on the third list becomes lookout No. 3. This is continued until a satisfactory amount of detection is obtained or until the addition made by each new point is so small that it is no longer economically feasible to add it. The value of each point which remains after the area of the higher ranking point or points has been subtracted is called the net *Du* value. A priority is thus set up when the points finally selected are listed in descending order of their net value. In other words, if only one lookout can be afforded, No. 1 is the proper choice; if only two, Nos. 1 and 2, etc.

This method of selection gives the maximum seen area in the most dangerous sections for the minimum per-acre detection cost.

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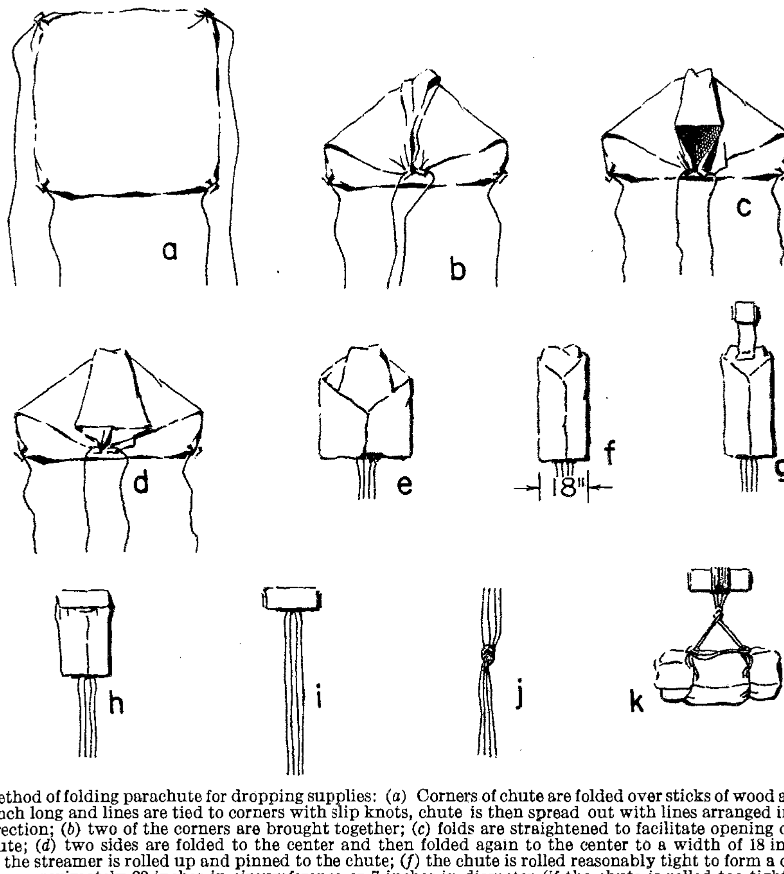
Hose.—Recently the National Fire Protection Association has issued a 40-page booklet entitled "Hose and Hose Couplings" which contains informative material on the selection, care, and testing of hose compiled from the recommendations of that association's committees and other authoritative sources. It deals with both cotton-jacketed, rubber-lined hose and with linen hose, giving useful information about testing, washing and drying, storage, use at fires, leakage tests, drying, etc. Although this booklet is prepared primarily for those using urban fire equipment, it deals with many of the same hose problems which we have, and is well written and fully illustrated. Single copies have been sent to each Forest Service regional office, but extras may be had at 25 cents per copy from National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.—Division of Fire Control, Washington.

FURTHER PROGRESS IN DROPPING SUPPLIES FROM PLANES

LAGE WERNSTEDT and L. K. MAYS

Region 6

Experiments conducted in search of a more practical method for satisfactorily dropping supplies from airplanes were described in the April 1937 issue of Fire Control notes under the heading, "Retarder Methods in Dropping Supplies from Planes." The findings of those tests were used last spring as a basis for 1-week training courses at Vancouver, Wash., and Pendleton, Oreg. One representative from each forest was trained in making and folding chutes and making up loads of all kinds, and was also given the opportunity of discharging the loads over a target.



Method of folding parachute for dropping supplies: (*a*) Corners of chute are folded over sticks of wood about 1 inch long and lines are tied to corners with slip knots, chute is then spread out with lines arranged in one direction; (*b*) two of the corners are brought together; (*c*) folds are straightened to facilitate opening of the chute; (*d*) two sides are folded to the center and then folded again to the center to a width of 18 inches; (*e*) the streamer is rolled up and pinned to the chute; (*f*) the chute is rolled reasonably tight to form a cylinder approximately 22 inches in circumference or 7 inches in diameter (if the chute is rolled too tight and stubby it is likely to drop with the fold or ahead of the bundle and fail to open at the beginning of the flight; if the roll is made too long and loose, the ends will bend upward in flight and prevent the roll from unwinding); (*g*) before the lines are rolled up on the chute, they are straightened to lie without crossing—the line should be rolled up snugly on the middle one-third of the roll in order to prevent any loop slipping off the end; (*h*) when the lines are rolled up, a knot is tied in the four strands 2 feet from the ends; (*i*) the ends beyond the knot are tied to the bundle.

In these courses it became quite evident that with proper training and management this method of transporting supplies could be made far more successful than had been anticipated. The trainees readily learned the methods used and the majority of the student droppers were on their first flight making hits averaging not more than 150 feet from the target.

During the training period some additional experiments and improvements were made. A method somewhat different from that described in the previous article was used in folding the chutes (a to h). Although either method is satisfactory this newer method is perhaps more readily understood where diagrams are used to describe it, and it results in a somewhat neater job.

Canned goods were dropped in 60-pound units. No. 2½ as well as No. 2 cans were used.

Dry foods and grain were packaged in weights up to 70 and 100 pounds, respectively, the grain sack being enclosed within a loosely tied wool sack.

Emergency rations in lots of 12, placed on two boards, were discharged. This is a two-tier load.

Eggs, packed in interlocking cartons, each containing a dozen, with nine cartons in a box and padded underneath with sliced white bread, were dropped without a single egg being cracked. A regular separator sheet was placed between the layers of cartons.

Matches were dropped without being ignited, in a bundle tied to a small chute made from a grain sack using string for shrouds.

Ten-man mess outfits and 3- and 5-gallon bottle-necked milk cans filled with water and gasoline were successfully discharged.

Radios of different types and varying in weight from 10 to 83 pounds were dropped without damage by using a bread-pad buffer. The 83-pound radio was attached to three chutes.

Axes, hazel hoes, and Pulaski tools were loaded in different combinations. Six axes or Pulaski tools, surrounded with four hazel hoes, came down satisfactorily with a single chute.

Five saws protected by hose guards and bolted to one board were dropped. In discharging saws, they should be held, hose guard forward, between the dropper and the door and against the rear door jamb at such an angle that the air strikes the upper surface of the saws. Thrust the end of the bundle out about 2 feet, then give it a quick shove downward. Only two hose guards were used for the five saws. A five-saw bundle is easier to discharge than a two-saw bundle on account of its added weight.

At Pendleton all loads were dropped from a height of 800 to 1,000 feet to a ground elevation of 3,900 feet. Later a special trip was made from Portland to Pine Mountain on the Deschutes Forest near Bend, Oreg., where miscellaneous articles were dropped without damage from 7,100 feet to a ground elevation of 6,200 feet.

Although to date most of the chutes used have been made from burlap wool sacks, burlap in about 7 by 7-foot squares may be purchased at a saving of 2 cents each, thereby also saving the labor of opening the sacks. Clothesline instead of sash cord for shroud cords also proved more economical. It is doubtful, however, as shown by later experience on actual fires, if clothesline is strong enough.

During the training period approximately 200 loads were dropped. Two or three chutes failed to open. A check of the cause of failure showed that some of the strands of shroud had slipped over the end of the rolled chute and that the odd loop prevented the chute from opening at the last turn (i). A loosely rolled chute tends to flatten and will not spin and open well (j). A very short and tightly rolled chute (10 inches) may also fail to open. It may fall as fast as some loads with the result that there is no pull on the lines to cause the chute to spin and open (k). The chute should therefore be rolled reasonably tight in a cylinder about 18 inches long and 22 to 23 inches around. The shroud lines should be rolled up snugly, but not too tightly around the chute. If any of the chutes have been flattened by the weight of other loads in the plane, they should be shaped up before discharging. A few feet of slack should be left between the bundle and chute when releasing, particularly if the load is bulky. The chute will then separate from the bundle and open more readily when discharged.

Use on Actual Fires

On July 26 a plane was ordered from Portland to transport supplies and equipment from Medford to the Cedar Camp fire on the Siskiyou Forest. If airplane service had not been available, it would have been necessary to truck supplies 31 miles over mountain roads and to pack them by horse 22 miles over a difficult trail. The initial food supply packed in with the crew was sufficient to provide supper for the 85 men on the fire, but it would have been 18 to 24 hours before additional food could have been taken in by ordinary methods. The plane dropped 1,857 pounds of supplies in four trips, using chutes. Items transported included groceries, meats, vegetables, fruit, grain, first-aid equipment, bed rolls, radio tubes, and batteries. All chutes functioned properly and the loss was negligible.

The second occasion on which this method of transportation proved advantageous was on the Wenatchee Forest, August 4, when the Pinnacle Peak fire broke out on the divide between the Chelan and Wenatchee Forests at an elevation of approximately 7,000 feet. Travel to this fire was by foot, 12 miles over the Entiat River trail and 2 miles of tortuous climb across country. Walking time averaged 10 hours for the crews. The fire camp was located about one-fourth mile from the fire, and it was impossible for pack horses to reach the site with a load. Had air transportation not been available it would have been necessary in this case to resort to back-packing. This would have seriously interfered with the suppression of the fire by prolonging control operations.

A tri-motored Stinson cabin plane was used on this fire. Three trips were made to the fire and 1,800 pounds of supplies and equipment were lowered by parachutes. Groceries, eggs, fruits, meats, mess equipment, back-pack cans and pumps, radio batteries, gasoline lanterns, saws, sledges, wedges, 5-gallon cans of gasoline, canteens, and headlights were dropped successfully. Losses amounted to about 5 percent and in every case were due to errors on the part of the dropper.

The largest project to date undertaken in Region 6 was on the Summit fire in the Wallowa National Forest, late in August 1937. A crew of about 400 men and 50 pack horses was supplied by airplanes during the entire control period of this fire. Approximately 120,000 pounds of supplies and equipment were transported to the

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camps on the Imnaha-Snake Divide. Two planes, a 6-place Travelaire cabin ship and a Bellanca 6-place monoplane, made a total of 141 flights from Enterprise, 28 miles airline, to the fire. Items dropped with chutes included canned goods, dry foodstuffs, eggs, fresh fruits, vegetables, meats, clothing, bedrolls, tobacco, telephones, No. 9 telephone wire, emergency wire, split insulators, telephone tools, headlights, gasoline and kerosene lanterns, radios, batteries, 5-, 10-, 25-, and 50-man tool outfits, Hauck torches, back-pack pumps, horse-pack water outfits, saws, 5- and 10-man mess outfits, first-aid equipment, 5-gallon cans of gasoline, oil, small cans of grease, hose for pumpers, cooking plates (cast iron), Kimmel stoves, Sibley stoves, tents, tarpaulins, grain, horseshoeing outfits, rope, and other articles. Bales of hay placed in wool sacks were dropped without chutes.

The ground elevation at points of dropping was more than 6,000 feet. The elevation of the planes varied from 6,200 to 7,500 feet, depending upon topography and air conditions.

Losses on Summit Fire

Losses on this project because of breakage were estimated variously by forest officers on the ground at anywhere from 4 to 6 percent, traceable in every case to improper preparation of the chutes and packages, or to attempting to lower bundles which were too heavy for the chutes. After the first day or so these troubles were practically overcome and losses thereafter were negligible. Even including the more severe losses at the beginning of the job, it is possible that an equal amount of damage would have been suffered had the transportation work been done in this rough country with truck and pack animals.

Pack horses in numbers sufficient to supply the camps were not available in the Wallowa country. If remount stock had been transported to the fire, it is estimated the cost of conventional methods of transportation would have equalled the cost of the planes. In addition, there would have been the serious matter of delay in delivery of food supplies and equipment.

Detailed Items

Several items were dropped on this fire that had not been dropped before.

Eggs were packaged differently with varying success, but it is believed that the method previously described is the best. The different layers of eggs should have a smooth, flat, and unyielding seat. A seat yielding in spots tends to set up strains through other layers and increases the breakage. The box container should be a reasonably stout one and the pad should be placed under the box.

Other important one-load items included—

4 empty 5-gallon milk cans; also 10-gallon milk cans (number not given).
4 lanterns in box.
4 sacks of bread.

One-half case of No. 2 and No. 2½ tins, carton cut in half lengthwise and placed on board (this makes a small and uneconomical load).
80-pound rolls of No. 9 telephone wire.
150 feet of hose in sack.
SPF radio set in box but without the heavy battery, one chute only used.
SPF battery, heavy, in box.
50 pounds grain in loose sack, when no larger overcoat sack was available to go around full sack.
3 empty back-pack cans.
48 flashlight batteries in regular box.
5 saws on one board.
140-pound bales of hay in wool sack (no chute).
5 gallons gasoline in milk can.
1 cast-iron cooking top, 18 by 32 inches, 35 pounds (out of 4, 1 broke; boiler plate would be better).

Specific Causes for Losses

Because of the fact that the trained dropper could not attend to the packing, several unsuitable loads were prepared, especially during the first few days. Most of the breakage was caused by failure in tying the loads strongly enough to prevent their breaking away, not suspending loads level (such as canned goods), not rolling chutes properly, using No. 6 sash cord instead of No. 7, loading some items too heavy (such as 25-man mess kits complete and 1-gallon jars of mustard), and using too light plywood boards (one-fourth instead of three-eighths inch or thicker).

Where it is necessary to drop 1-gallon tins (No. 10), as supplied by the Army for the Civilian Conservation Corps, it seems to be the concensus that a chute will take care of four tins. In order to relieve the greatly increased strain on these large tins, a stout string should be drawn tightly around the cans near the bottom and another near the middle. Potatoes vary greatly in firmness, and the load may have to be reduced to 30 pounds for some potatoes.

General Comments

Several points of major importance have been disclosed in putting the retarder method of dropping supplies into actual use:

1. More advance preparations are desirable in packaging standard outfits. A fairly large supply of prepared chutes, sash cord or clothesline, small manila rope, plywood, and streamer cloth should be maintained at strategic points in the region. Such points should be in towns where airplanes suitable for dropping are available and as near as possible to areas where it is probable that this method of transportation will be used. In deciding upon the number of chutes and the amount of other material, thought should be given to the fact that it is nearly always impossible to get chutes returned promptly from the fire to the supply base. In some locations it may be impossible to get them returned at all.

2. A well-trained and managed organization is necessary for the larger jobs. Such a crew should consist of a man in charge of all dropping activities; a packaging crew of four or five men; two men preparing and rolling chutes and streamers; one man to mark and record contents, weight, and distribution of bundles; one driver for transporting bundles from the warehouse to the airport; field crew of three men to load bundles and service planes; a trained dropper for each plane; and a responsible man in charge of each target in the field to check and route the supplies dropped. This crew should be adequate for loading an average of three planes an hour. Two men from each forest should be trained so that one man may supervise the packing while the other man is engaged in dropping. The latter should preferably be familiar with the forest.

3. Where it is planned to use the airplane method of transportation, a reasonable number of standard fire-fighting outfits, together with the chutes, should be packed and stored ready for loading into the airplanes.

4. It is the tendency under emergency conditions to overload the chutes. If it is necessary to drop packages of more than the standard approved weights, two or more chutes should be used on each load. The following maximum weights have been established for various groups of items to be dropped on one 7- by 7-foot chute. These figures are based on air conditions up to 6,000 feet elevation. Some reduction in weights should probably be made where elevations are more than 6,000 feet.

	Pounds
(1) Canned goods, No. 2½ tins or smaller	55
(2) Dry foods and meats	70
(3) Vegetables	30
(4) Eggs, fresh fruit, radios, telephones	20
(5) Mess equipment	40

Loads of items such as tools, tentage, bedding, clothing, etc., are not usually governed by weight but rather by the bulk and shape that it is possible to discharge from the plane.

5. Although some latitude in packaging goods is necessary and desirable, no great departure should be made from those methods which have been tested and checked and found satisfactory, unless the man responsible for the packaging is very familiar with and thoroughly understands all phases of the job.

6. Clear-cut instructions for packing should be available in all warehouses where dropping operations may be used.

Experience gained in the summer of 1937 in the use of airplane transportation on actual fires bears out the statement made in the April 1937 report regarding use of this method:

> It is not only possible, but easy and simple to drop every sort of supplies and equipment in substantial quantities and with sufficient accuracy to be found by the ground crew, and to do so without any loss or damage whatever to either supplies, equipment, or containers.

TRACTOR TRAILS

K. W. HEUSTIS

Associate Forester, Los Padres National Forest

The article by Mr. Cowan, "Tractor Trails Versus Horse Trails" in the August 1937 issue of FIRE CONTROL NOTES and this report by Mr. Heustis, suggest that within a few years, transportation from roadside to fires may be revolutionized. As a matter of sentiment, we may prefer the horse and mule to the machine, but we must admit that pack-train transportation is slow and expensive. Pack animals and skilled packers are constantly harder to obtain. Animals get tired while machines can readily be worked the full 24 hours per day which fire-fighting operations demand. The picture of the future suggested by these articles includes trails traversable by horses and tractors but not by cars and trucks and constructed at a fraction of the cost of truck trails and with enough outslope to solve permanently the drainage and maintenance problem; tractors equipped with trailers for hauling men and supplies and front-end blades for fire-line construction; and high-power, high-speed trucks for transportation of tractors and trailers from central warehouses to roadside points nearest the fires. Fire-control men in other portions of the country will wonder why the author omits reference to the single-horse, reversible plow, and trail grader for construction of horse trails at a cost far below that of hand work. However, valuable as the horse and plow are for horse-trail and fire-line construction, the tractor with front-end blade should be a much better tool for construction of tractor trails. Little of the hand clearing necessary for horse work would be required for operation of the machine.

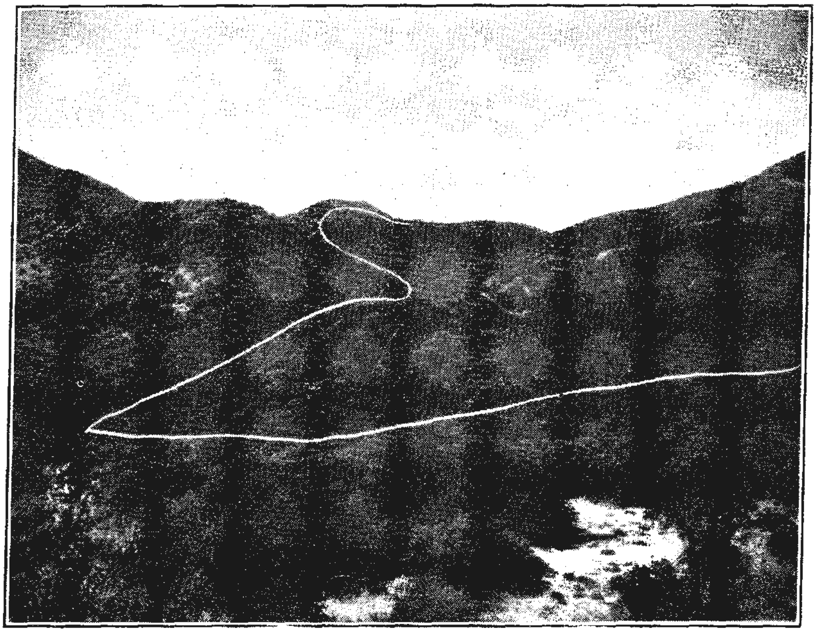
Opening up the back country for the quick and easy movement of men and supplies into highly inflammable areas has always been an expensive and complicated problem. In the past, our only way out has been the construction of truck and horse trails.

Construction of truck trails is very expensive and calls for an annual heavy cash outlay to keep the trails in passable shape. In addition there is growing public opposition to cutting primitive country with roads and providing free and easy access for hordes of people who may trample and destroy Nature's handiwork. It would seem, therefore, that this type of access to the back country is necessarily limited and that such work in the future will be greatly curtailed.

The horse trail at present is serving to make the isolated area accessible, but, of course, this means of travel is slow and expensive since such trails must be dug and kept up by hand labor.

Considering these facts and the possibility of constructing with machinery some sort of narrow trail that would meet requirements as to cost, upkeep, and means of fairly fast transportation in the event of fire, we started casting about for a small tractor trailbuilder. After some discussion as to the merit of a project of this type, our procurement office was able to borrow a caterpillar 22 with a trail-builder attachment.

The trail job picked for this experiment was approximately 3.3 miles in length. Starting at an elevation of 5,500 feet, the trail traversed country heavily covered with chaparral, with many steep slopes and ravines. The brush was very dense and ranged in height from 5 to 10 feet, with many scattered scrub oaks. The slopes ranged in steepness from 5° to 60°. The formation consisted mostly of shale, very hard in places. A considerable number of sandstone boulders and two very hard shale ledges were encountered, which called for the use of dynamite.



Trail followed showing gradient and type of country traversed.

The brushing, which was done by a crew of Civilian Conservation Corps enrollees, was varied in width; 11 feet would be a good average. Some trimming up was necessary in places to get a uniform appearance after the tractor had excavated the tread.

The tractor used on the job had a 40-inch tread with 10-inch shoes. The first attachment used on the machine was a cable lift, bulldozer type, which was soon discarded because the blade could not be set at an angle. An angledozer type attachment with hydraulic lift was then placed on the machine, which increased production considerably. The overall length of the blade was 6 feet 6 inches, and when set at an angle was 6 feet 1 inch. This permitted the construction of a trail averaging about 5 feet 5 inches in width. Although this is more width than is necessary, past experience has shown that the width in two years will be reduced about 1½ feet by settlement, slough, and erosion of the fill section.

A narrower trail (about 3½ feet) would be much cheaper and would, no doubt, serve the purpose just as well, but would necessitate the special design of a narrower tractor.

A small Schramm compressor designed for horse-trail construction and mounted on rubber-tired wheels was used to good advantage in the rock sections and reduced the cost considerably.

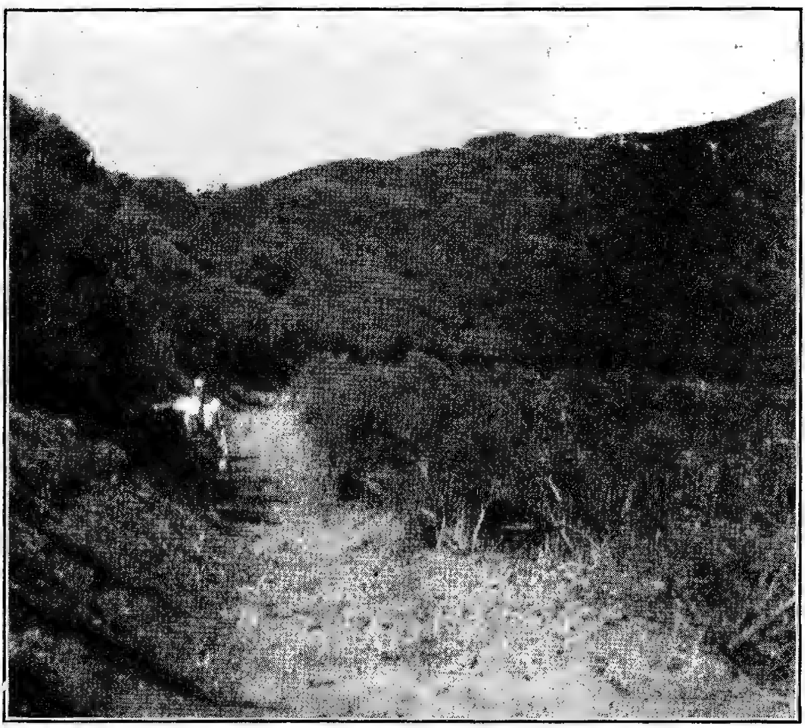
When this trail was started, we believed we could construct a wider trail with a trailbuilder and still beat the cost of a narrower trail constructed by hand, which the final figures seem to verify. However, 3.3 miles is not sufficient length to permit us to state

Tractor trail builder at work.

definitely that the tractor method is the cheaper in all types of formation. The 3.3 miles constructed cost an average of $406 per mile. There were two paid men on the job (one operator), and all labor was furnished by the Civilian Conservation Corps. Much time was lost at the beginning in experimenting and getting the job under way. On 10 miles of such work the cost might be reduced $100 to $150 per mile. A horse trail constructed through this same country by hand labor would cost approximately $800 per mile.

A trailer was constructed of the salvage parts from a 1½-ton truck for transporting materials and supplies to the job. The frame was cut down to about 9 feet in length, and dual wheels, taking 36- by

View showing initial cutting of trail.



Finished section of tractor trail.

View of trailer, showing castor wheel.

6-inch tires, were placed under the front with a width of 4 feet center to center. A castor wheel with a 36- by 6-inch tire was placed in back, to aid in keeping the trailer in the tread of the trail on sharp curves. The trailer, which was designed to carry about 2 tons, has worked remarkably well, but it is evident that its purpose would be served much better if the size of the wheels were reduced.

Although it was the intention to use pack stock for transporting supplies in case of fire, we were really shooting at a medium between

Tractor and trailer.

the expensive truck trail with its fast transportation and the horse trail with its slow and costly means of transporting supplies. It is our belief that if a small tractor which would handle a blade of not more than 50 inches in width could be designed for excavating purposes, and a draft tractor, of the wheel type with rubber tires and with a speed of about 4 to 5 miles per hour, could be constructed to handle a low trailer of about 1½ tons capacity, our problem of transportation into isolated areas would to a great extent be solved.

* * * * * * *

No More Loose Handles.—In his article in Fire Control Notes of August 9, 1937, Fred W. Funke described a method of hanging new axes to prevent loosening on the handles, which involved the use of two 3/16-inch steel rivets through the ax eye at right angles to the axis of the handle, in place of the conventional ax handle wedge.

Striving for the same result in axes which had previously been hung in the regular way, Ranger H. H. Oft of this forest, at the suggestion of J. F. Campbell, in charge of fire control in region 6, instituted a study employing the rivet idea. His method of approach is slightly different from that described by Mr. Funke, but the results are just as encouraging.

The system developed and used here during the past season may be broken down into four simple operations which can be done with tools on hand in most any ranger district fire warehouse, at very nominal cost:

1. Bore a single 3/16-inch hole through the center of the ax eye and handle.
2. Countersink the hole in both sides of the ax eye to a depth of about 1/16 inch with a 3/8-inch drill.
3. Pass a 3/16-inch soft iron round head rivet 1 inch long through the hole and set it securely in place with a ball pein hammer.
4. File either end of the rivet down until it is flush with the surface of the ax eye.

This makes a neat job and the presence of the rivet is not objectionable to even the most experienced axman.

Axes and Pulaski tools treated in this manner were subjected to varying degrees of use during the past summer and without exception their handles stayed perfectly tight. No tendence of the handle of a tool to rock in the eye was noted, due probably to the presence of the wedges.

It is believed that this method of permanently securing the handles in axes and Pulaski tools which have already been hung in the conventional way is entirely adequate and that it offers a very simple and inexpensive solution to a problem which has long vexed those of us who have been responsible for the maintenance of fire-tool caches in climates where the air moisture content varies between wide extremes.—Dahl J. Kirkpatrick, Deschutes National Forest.

DEVELOPMENTS IN THE ONE-LICK METHOD

J. F. Campbell

Region 6

This method of fire-line construction with its promise of increased efficiency has become the subject of widespread interest. It was first reported in Fire Control Notes in the December 1936 issue covering the 1935 tests. Mr. Campbell now describes the elaboration of the subsequent work that has been done. The scheme is not new—the basic idea was proposed more than 20 years ago, when it was dubbed the "One-Lick Method," which term is quite expressive of the action and has taken hold generally among fire-control men. Region 6 appears to favor the use of the original term. Terminology can, however, await the glossary revision—the method is the important thing.

Some preliminary tests and actual uses of the progressive method of fire-line construction were made in 1935 on the Rogue River National Forest. This work, which was reported in the December 1936 issue of Fire Control Notes, offered so much promise it was obviously desirable to further develop the method.

During the fire season of 1936, each supervisor was requested to organize and train a 40-man crew in each Civilian Conservation Corps camp on his forest in the use of the method. Many interesting points were brought to light during tests and on actual fires during that season.

In the winter of 1936–37, at the Portland meeting of the fire assistants from all the forests in the region, a committee was appointed to outline means of further developing the method along lines suggested by Mr. Roy Headley, particularly in connection with the overhead organization. The committee decided to assign the development work to four forests having entirely different topography and fuel conditions—the Columbia, Rogue River, Snoqualmie, and Umpqua. The requirement to organize and train Civilian Conservation Corps crews was again made effective during 1937 and much new information was gained. In addition to the accomplishments on the four designated forests, rangers on the Siuslaw and Siskiyou National Forests did particularly outstanding work.

As might be expected, some of the experiments tended to deal more with the method itself than with the overhead organization, which was really the problem assigned for study. This tendency arose from the fact that wide variations in fuel types naturally require variations in the organization and equipment of crews. It is obvious that a crew using the method in open ponderosa pine country would require less of a clearing unit than a crew of the same size in the Douglas fir type having an understory of brush.

In some types of fuel it was discovered that in order to keep the crew moving smoothly ahead it was desirable to equip one squad of men with Pulaski tools. This enables the squad to strengthen the clearing crew when necessary and then return to trenching between thickets. In some types it was found desirable to provide one or two men to throw brush out of the line after it was cut. Types of equipment used must be decided upon locally for each fire and will depend, of course, on the type of fuel.

Another important point which came to light during the 1937 season is the absolute necessity for recognizing the difference between mere fire-line *construction* and the job of *holding* the fire line. Figures based solely upon the rate of line construction in Region 6 do not mean much because usually more man-hours of work are necessary to hold the line than are required to construct it.

The point mentioned is important because, until the dual nature of the fire-line job is recognized and provided for, the progressive method might fail to accomplish its purpose, for obviously there is no point in constructing a line unless adequate provision is made to hold it. Example: Suppose that a crew of 100 men is available to suppress a going fire. The fuel type should be sized up and the best possible estimate of time required to construct the line should be made. The figures should be considered in determining the number of men to be used in the *construction crew.* The difficulty of *holding* the line from the time it is constructed until it has been mopped up to a point of safety should also be carefully estimated, and an adequate number of men provided for the job. This work includes such jobs as snag falling, burning out material between the line and the fire edge, and reduction of hot spots. When the line is started around the fire it would, of course, be foolish to divide the construction crew from the holding crew. Rather, at the beginning, the entire group should be used to construct line and men dropped from the rear as the construction progresses. Each man so dropped should be given a definite piece of line to hold or other definite duties to perform. Between the line construction crew and the patrolmen there must be special units to perform such duties as burning out, snag falling, log bucking where necessary, and back-pack pump work.

Those who have used machinery in fire-line construction may picture this idea more clearly by considering that the line-construction crew takes the place of the swampers and the tractor-plow unit, and that the line-holding crew must be provided to perform the same duties as the manpower organization which has been found so necessary in connection with the use of machinery.

Back to our example: The 100 men might be divided as follows: 40 men in the *construction* unit and 60 men in the *line-holding* unit. The entire 100 men, with the exception of torch men, snag fallers, and other specialists designated by the fire chief, would line out up the hill doing construction work one lick at a time as they proceed. Before long the last man would find that 100 yards of line had been completed. Following instructions previously given by his straw boss, he would then drop out of the construction crew and become a patrolman. As soon as another section of line of the designated length had been constructed, the next man would drop out and become a patrolman, and so on until the fire had been corralled. As soon as the line construction crew had completed its task it would become a part of the mop-up force.

Although the different forests working in the different fuel types arrived at slightly different conclusions as to the exact overhead organization necessary, it seems evident that for the present the following minimum overhead organization is essential:

One general foreman or fire chief in charge of the sector or fire. This man moves up and down the line to make sure that a satisfactory job is being done and that unnecessary work is held to a minimum. He may find it necessary to have a messenger to carry instructions to the line locator or to the various straw bosses. As a substitute for this messenger, it has been found satisfactory in some cases for the general foreman to equip himself with a police whistle and to outline a system of signals which may be heard by the line locator and the straw bosses.

When the foreman determines that the line is being too elaborately constructed, he can promptly give a signal for the line locator to move ahead at a more rapid pace and when the reverse is true, a different signal may be used to slow down the movement.

One scout or advance-line locator works ahead of the man who actually designates the location of the line. The purpose of this job is to keep the line locator informed of the fire behavior and fuel conditions where visibility is impaired by brush, timber, smoke, etc.

One line locator designates the actual location of the fire line. This man decides upon the amount of clearing necessary and passes instructions back to the clearing crew.

One straw boss with each squad of seven men. These straw bosses are necessary regardless of what class of line work the squads are doing. The straw bosses are in immediate charge of the squads, give them instructions, keep the men properly lined out and spaced, and look out for their safety. They are in charge of any special work to which their squads may be assigned, such as clearing the line, trenching, burning out, and snag falling. They must, of course, be competent and well trained in their duties.

Straw bosses should not be required to carry tools or to perform labor on the line, because their time is fully occupied and of more value if devoted wholly to supervising the work of their squads. They should carry a first-aid kit and canteen or water bag.

The foregoing outlines the minimum overhead organization for a *line-construction crew* of from 40 to 60 men. A foreman and an adequate number of straw bosses must also be provided for in the *line-holding crew.*

Adequate provision for water boys is even more necessary where this system is used than where the conventional sector method is employed.

With the progressive method there is no opportunity to "gold brick." Every man is lined up in his place and must move forward with the crew. There is no chance to lean on the shovel or sit down for a smoke unless the entire crew stops. Doubtless this has much to do with the faster rate at which fire line is constructed. The point is important, because it involves the fatigue factor. The overhead must remember that men become exhausted sooner when working in these crews. Occasional brief rest periods must be provided. Furthermore, a crew cannot work long shifts where this method is used, and in cases where the corral action will last more than 8 hours at most, a relief crew must be provided. Estimates of the time a crew can keep up the pace vary, of course, between forests and with fuel types, topography, etc. Estimates range from 4 to 6 hours in our reports this year. I am stretching things a bit when I use 8 hours as the maximum period of work.

A general idea of the effectiveness of the one-lick method may be gained from the following information reported by forests using it:

Forest	Fuel type	Progressive method	Conventional method
		Chains per man-hour	*Chains per man-hour*
Columbia	Douglas fir slash, reproduction, some snags (MH)	0.59	0.13
Colville	Brush, grass, logs (ML)	2.00	.5
Deschutes	Lodgepole and ponderosa pine, brush, reproduction (ML)	.8	.5
Umpqua	Bug-killed lodgepole pine, 50 percent dead and down (MH)	.9	.43
Rogue River	Dense brush (HM)	1.00	.35
Willamette	Dense brush and fir reproduction, some snags and logs (MM)	.48	.26

The figures in the table relating to the conventional method were taken from an average for each fuel type worked up from a study of 929 reports. One important point which should be considered is that cooks, timekeepers, and others not on the line (overhead) are included in figures for the conventional method. Actual line production shown is, therefore, slightly lower than the actual accomplishment.

A report of tests conducted on the Hebo ranger district, Siuslaw National Forest, is of interest because it indicates that the usefulness of the method is not limited to relatively open fuel and timber types. The Hebo district is situated on the coast in northwestern Oregon and the dense types of vegetation generally present along the coast must be dealt with in fighting fire. Bracken fern, salal, and huckleberry brush, and dense Douglas fir reproduction are included. Most of the area was severely burned over many years ago and numerous logs in various stages of decay are on the ground. In short, the fuel types and topography are about average for the west side forests of this region.

Ranger Robert Aufderheide's report follows:

On July 22, 1937, a crew with Foremen Johnson, Thorall, Scheese, Tyson, and Troutt was given training and practise in the progressive method of fire-line construction.

Upon arrival at the scene of the test the crew members were lined up with the tools they were to use and the one-lick method was explained. Instructions were also given to the several special men and strawbosses. Approximately 10 minutes were so used. As far as is known, none of the men was acquainted with or had had any previous experience with this method.

Tests were run in 30-minute stretches with approximately 7-minute rest periods.

The first test was made with only 31 men, because part of the crew was late.

The other four runs were made with from 45 to 47 men per crew.

No mop-up crew was used or patrol dropped off. Logs were quite wet, and peeling and clearing out underneath them was sufficient.

Conditions

Cover types are indicated in the table. The number of logs was not counted, but it is thought to be about average for the district. Cover type was taken for more than 7,700 feet up a ridge and was thought to be representative of the district. Topography also was about average.

Test and Results

The results of the five ½-hour runs are shown in the following table (runs 4 and 5 are combined).

The average of all five runs was 1.10 chains, or 72.9 feet per man-hour. No snags were felled or logs bucked.

The trail averaged about 2 feet in width, with the clearing about 3 feet.

The men cooperated splendidly. No complaining was heard, but there were many favorable comments.

I am inclined to believe, from the results of these tests, that a 40- to 45-man crew is about right and that a separate crew to take up patrol should follow. However, more experience with the method is needed.

I am also inclined to believe that about 4 hours is the maximum a crew can efficiently produce by this method. If corral time is longer, a new crew should be obtained.

Recommendations

1. A brush thrower to follow clearing crew.
2. Brush knives rather than axes to be furnished the scout and fire-line locator.

Different types of vegetative cover encountered on each run	Distance in feet for each test run [1]			
	No. 1	No. 2	No. 3	No. 4
4-foot fern, 2-foot salal, 5-foot thimbleberry, medium to dense Douglas fir reproduction, 10 to 20 years	66	105	------	------
Dense Douglas fir reproduction, 10 to 15 years, undergrowth medium to dense	270	------	------	------
Fern, salal, thimbleberry, Douglas fir reproduction, 10 to 15 years, some logs	515	------	------	------
Second growth Douglas fir, some logs, salal, and huckleberry	100	880	------	------
4-foot salal, dense	------	110	------	------
Small alder, dense, with some brush and logs	------	246	------	------
Alder, Douglas fir, hemlock, and some brush	------	------	360	120
Vine maple and hemlock	------	------	150	------
Alder, some brush, and fern	------	------	1,300	1,140
Alder-Douglas fir, 20 years, some brush and logs	------	------	------	990
Alder-Douglas fir, with medium huckleberry, thimbleberry, and salmonberry	------	------	180	150
Large spruce, hemlock, Douglas fir, with alder, medium logs, and brush	------	------	------	180
Douglas fir, 20 to 40 years, medium brush and logs	------	------	------	720
Total feet of trench constructed for each test run	951	1,341	1,990	3,450
Time (minutes)	29.5	30	29	60

Tools and personnel	Number of each in each test run			
	No. 1	No. 2	No. 3	No. 4
Scout	1	1	1	1
Fire line locator	1	1	1	1
Clearing crew:				
Straw boss	1	1	1	1
Axmen	4	8	5	5
Brush hooks	2	2	2	2
Brush thrower	------	------	1	1
Fire line specifier	1	1	1	1
Pulaski crew:				
Straw boss	1	1	1	1
Pulaskis	5	5	5	5
Brush hooks	1	3	3	3
Shovels	1	1	------	------
Axmen	------	------	------	------
Digging crew:				
Straw boss	1	2	2	2
Hazel hoes	6	16	16	15
Shovels	2	1	2	2
Axmen	------	------	1	1
First-aid men	1	1	1	1
Foremen	1	1	1	1
Waterboys	2	2	2	2
Total number of men	31	47	46	45
Man-hours	15.25	23.5	22.22	45
Feet per man-hour	62	57	85	77
Chain per man-hour	.94	.86	1.30	1.16

[1] The distance of feet of trench on each run shown under the vegetative cover encountered, was built by the men and with the tools listed under the corresponding run number.

3. Strawboss of clearing crew be a man capable of alternating with fire-line locator.
4. Older men be detailed as hazel-hoe men at rear because they will last longer, having an almost completed trail on which to walk.
5. Detailing sufficient water boys to keep the crew supplied with water.
6. Include one shovel man with the clearing crew to cool down hot spots.
7. A hoe and axman to follow clearing crew to bark and clean out underneath down logs.
8. Further experiments be made, particularly on going fires so as to work in the burning-out crew, fallers, and patrol crew.

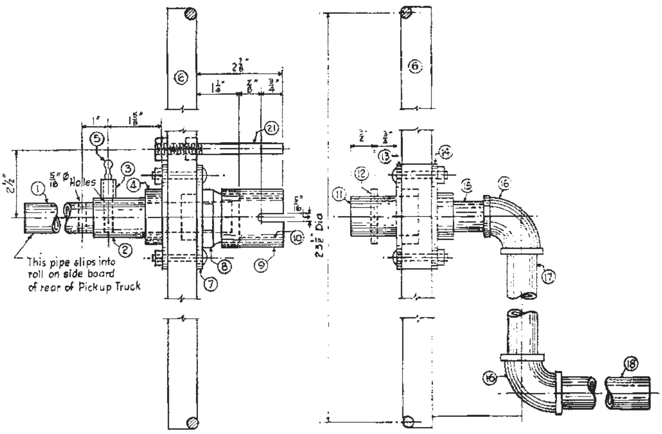
The method was used here and there throughout the season on actual fires, but the reports are not numerous or complete enough to use as a basis for accurate conclusions. However, the tests conducted to date as well as the use of the method in constructing line on actual fires indicate in every case that it has great possibilities of speeding up the rate of line construction. Anything which holds even a glimmer of promise of increasing speed is well worth serious thought and study by all men concerned with forest-fire suppression.

REEL FOR COILING FIRE HOSE

FOREST PROTECTION DIVISION

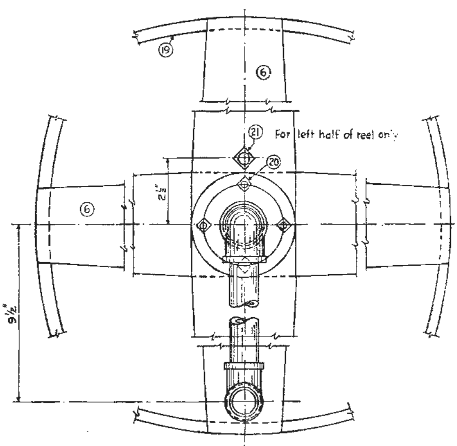
Wisconsin Conservation Department

The reel illustrated was designed and is used by the Forest Protection Division of the Wisconsin Conservation Department for coiling



LEFT HALF OF REEL

RIGHT HALF OF REEL



ELEVATION OF RIGHT HALF OF REEL

MARK	NO.	DESCRIPTION	REMARKS.
1	1	Pipe ¾" x 22¼"	¾" Thread One End
2	1	Pipe 1" x 2½"	" " " "
3	1	Pipe ⅜" x ¾"	Weld to 2
4	1	Floor Flange 1" x 3½"	Tap for Std Pipe Thrd
5	1	Window Spring Bolt	
6	4	1" x 3½" x 24" Board	Notch at ends for ⅜" band cut at center to form half joint.
7	1	Floor Flange ¾" x 3½"	Drill to sliding fit for ¾" pipe
8	1	Bushing 1¼" x ¾"	
9	1	Coupling 1¼" x 2⅛"	Bush with 10 and slot
10	1	Pipe 1¼" x 1½"	Thrd full length to fit 9 + slot
11	1	Pipe 1" x 2¼"	Thread ⅞" One End
12	1	Pin ¼" ø x 1⅞"	Drill 11 for driving fit with 12
13	1	Floor Flange 1" x 3½"	Tap from underside of Flange
14	1	Floor Flange ¾" x 3½"	Tap for Std Pipe Thread
15	1	Pipe ¾" x 2"	Thread ⅝" each end
16	2	Elbows ¾"	
17	1	Pipe ¾" x 8½"	Thread ⅝" each end
18	1	Pipe ¾" x 5½"	Thread ⅝" one end
19	1	Hoop ⅜" ø x 6'-1¾" (23½" Dia.	at ℄ of rod) Fasten to 6
20	8	Round Head Bolts ¼" ø x 1¾"	For bolting 6 to flanges
21	1	Rod ⅜" ø x 4¼" 2-Nuts	Thread Rod 1⅛" one end

Reel for coiling fire hose.

hose in readiness for packing or transportation. The principal virtue of this reel is that it is highly portable and may be readily used in the field to take up hose after a fire.

The reel is designed for attachment to the back of a truck or work bench or any similar location. The section showing the left half of the reel indicates a ¾-inch pipe. Part 1 is of such size that it will slip into the rolled edge of a Chevrolet pick-up box. The hose reel may be operated easily from this type of suspension. For larger trucks, or for trucks with a different type of body, a round hole ¾-inch in diameter could be provided in the rack for suspending the hose reel.

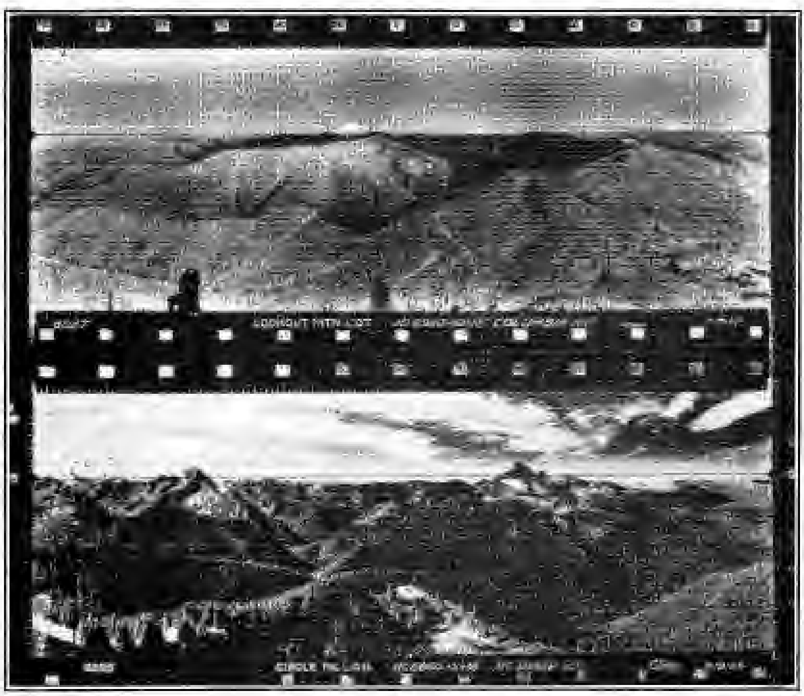
VISIBILITY MAPPING FROM PANORAMIC PHOTOGRAPHS AS USED IN REGION 6

L. K. Mays

In formulating a detection plan for the national forests in the North Pacific region, plotting visible areas from lookout points by means of panoramic photographs was originated and perfected by Lage Wernstedt. The work had been carried on casually for several years prior to 1933, but during that year an intensive program of visibility mapping was begun. As the work progressed, several minor changes and revisions were made by various persons connected with the project, but the technique remains essentially the same.

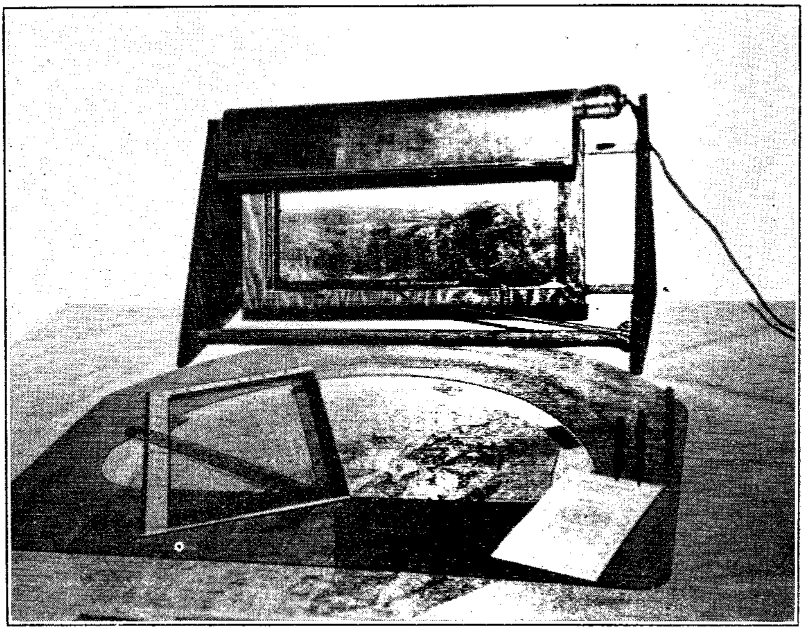
The following features adapt the panoramic photographs to visibility mapping:

1. *Level line.*—By means of a paper vertical-angle scale elevations of other mountains or topography may be determined from the known elevation of the camera's level line.
2. *Azimuth scale.*—The camera is oriented in reference to true north and the proper azimuth readings are recorded upon the film, allowing degrees and fractions thereof to be read.
3. Each photograph covers 120°, or one-third of the circle. Three photographs are needed to complete the panorama and are taken with the Osborne Photo Recording Transit.

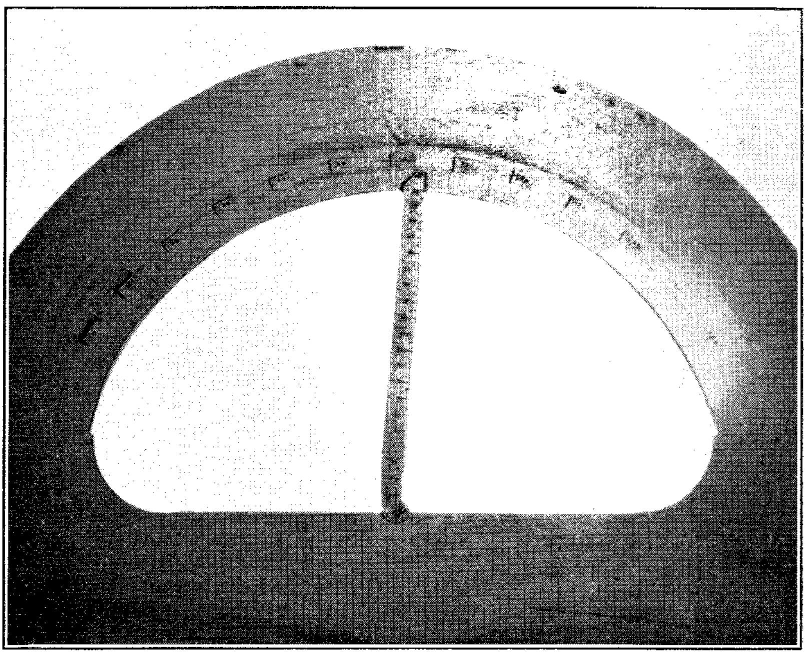


Sample panoramic photographs.

The visible areas are plotted upon ½-inch scale United States Geographic Survey quadrangle sheets, if available for the areas to be mapped. A base map may be substituted if necessary, but to obtain the most accurate results, contour lines are essential.



General layout used in visibility mapping.



Semicircular protractor used.

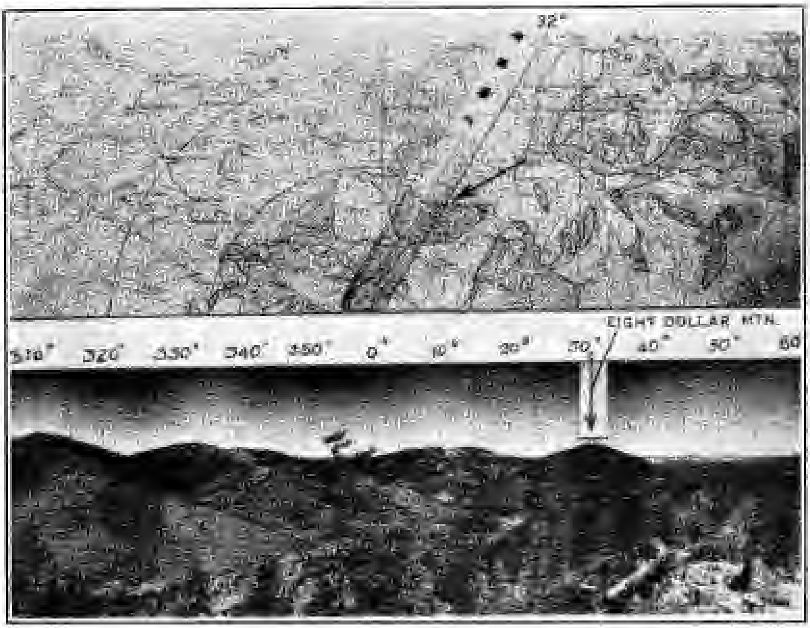
The sheets are pieced together to form one map with a radius of 15 miles from the point occupied.

The map is then placed under a large semicircular protractor.

This protractor is made of celluloid 0.030 inch thick, with a 20-inch semicircular opening cut out and graduated into 130°.

The lookout occupied is placed directly under a pinhole in the center of the protractor and fastened in place by a push pin put into a drawing board beneath.

The map is then oriented in reference to the photographs, and by using a straightedge, the correct azimuth readings may be laid off directly on the map. This allows the exact determination of the lateral extents of ridges or the horizontal boundaries of any object seen on the photographs.



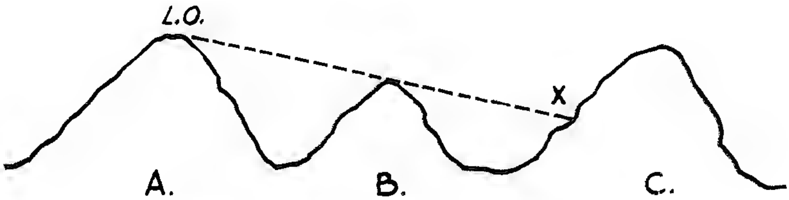
Map oriented in reference to photograph.

The next step is to determine the lowest limits of visibility on ridges or the vertical extent of the line of sight. The straight line of vision when looking over one ridge onto another drops as the projection of a straight line from the lookout (see accompanying sketch) across the top of the intervening ridge (B) and intersects the second ridge (C) at the point (X).

As the line of sight is projected over the ridge (B) onto ridge (C) the distance (LO) to (X) is unknown.

Two calculations are necessary to determine location on the map of point (X): (1) The rate of drop; (2) the distance from A to B, which may be taken directly from the map.

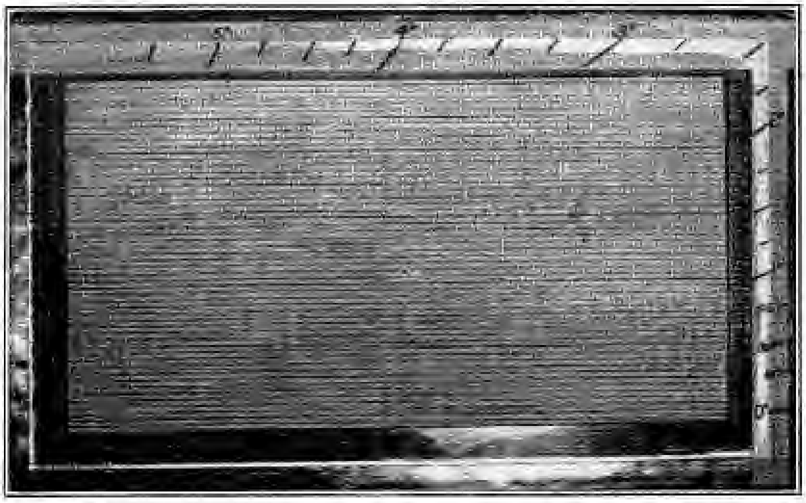
These measurements are simplified by using a "harp" or profiler designed in this region. The frame of the harp is of metal or celluloid 7 by 11 inches outside and 5¼ by 10 inches inside. Small holes evenly spaced, 10 to the inch, are drilled in each end of the frame.



Diagrammatic sketch showing lower limit of visibility.

Fine silk fishline (2- or 3-pound test) is strung back and forth on the frame to form a series of parallel lines.

This harp is then superimposed on the map (which is under the protractor) and 100- or 200-foot values are assigned to each string.



Harp or "profiler."

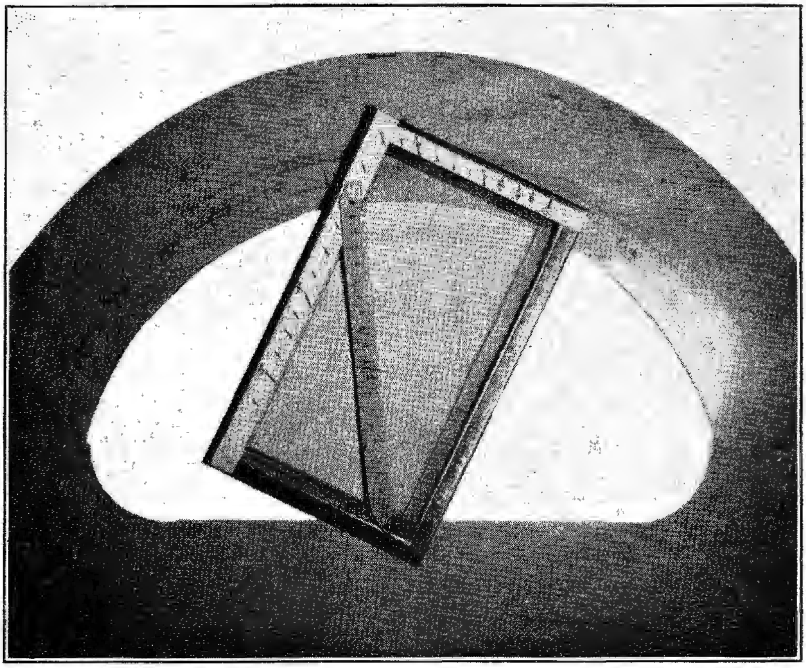
The following steps are followed in using the harp:

1. The string hole, corresponding in elevation to the lookout, is placed over the map and a push pin put through the straightedge, profiler, protractor, and map at the lookout location and into the drawing board.
2. The string corresponding to the elevation of (B), obtained from the contour map, is placed over ridge or point (B).
3. The straightedge is swung around so it also cuts across ridge (B).
4. The elevations are noted along the line of sight or straightedge on ridge (C) until a contour on (C) and a string of the same value on the harp coincide. This is the point (X).

By using this method progressively from ridge to ridge, profiling becomes a rapid, effective, and accurate process.

When the ridge or object obstructing the line of sight is located too close to work within the harp, the 200-foot values should be assumed for the strings.

A paper vertical-angle degree scale accompanies each set of photographs and may be used in conjunction with the harp to determine the elevation of any point of topography as follows:



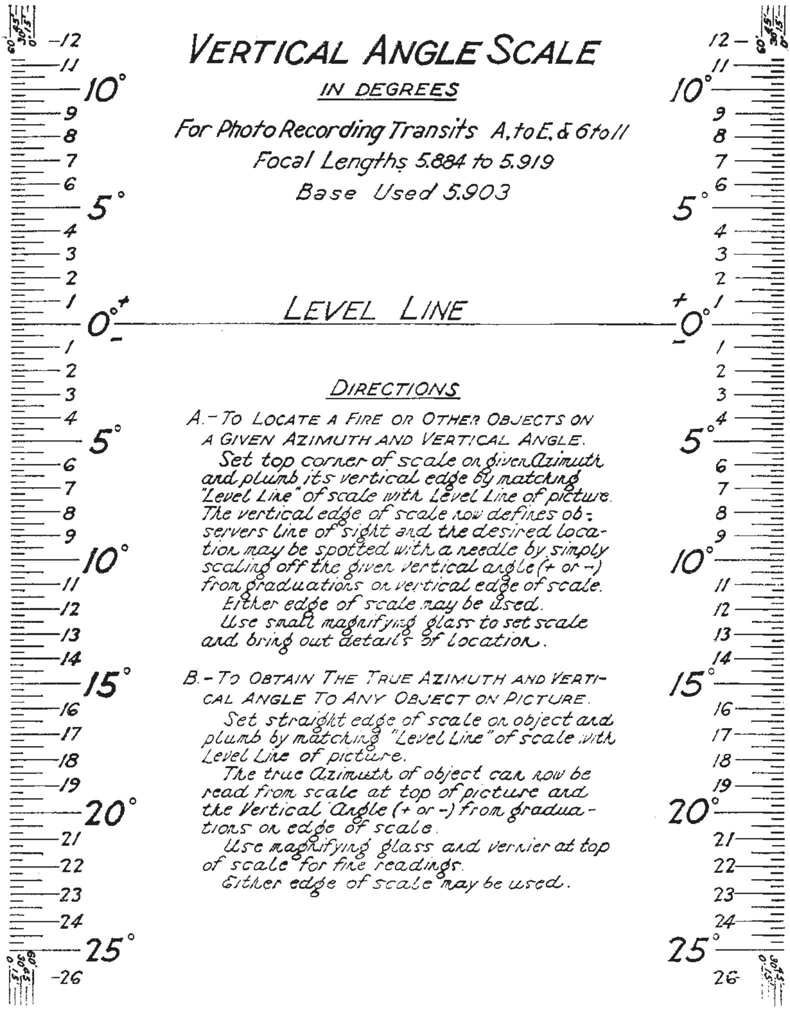
Superimposing harp or profiler.

The 0° mark on the scale is placed at the level line on the photograph and a reading in degrees is taken to the top of the intervening ridge. A pin is placed through the straightedge, through the lower right string hole in the harp, and through the map at the point occupied. The straightedge is placed on the same degree reading on the side of the harp as was obtained by the vertical scale. Follow along the straightedge until a string is found that coincides with a contour on the nearest visible ridge. This point is the intersection of the line of sight with the ground.

Both the lateral extents and vertical extents of the seen areas are now found, so the outline of the visible patches may be traced in and colored. It is quite essential to keep in mind the fact that the line of sight is straight and cannot be bent around shoulders on ridges or down the blind side of ridges.

Profiling by this method may be used only on topographic maps. Where only base or drainage maps are available, the mapper will have to estimate the vertical extents. The lateral extents may be read from the photographs and plotted directly. Only one who is experienced in visibility mapping on the topographical sheets should attempt mapping for base maps. Such work requires experience and practice to judge the areas with any degree of accuracy.

Illustration of vertical-angle scale will be found on following page.



Vertical-angle scale.

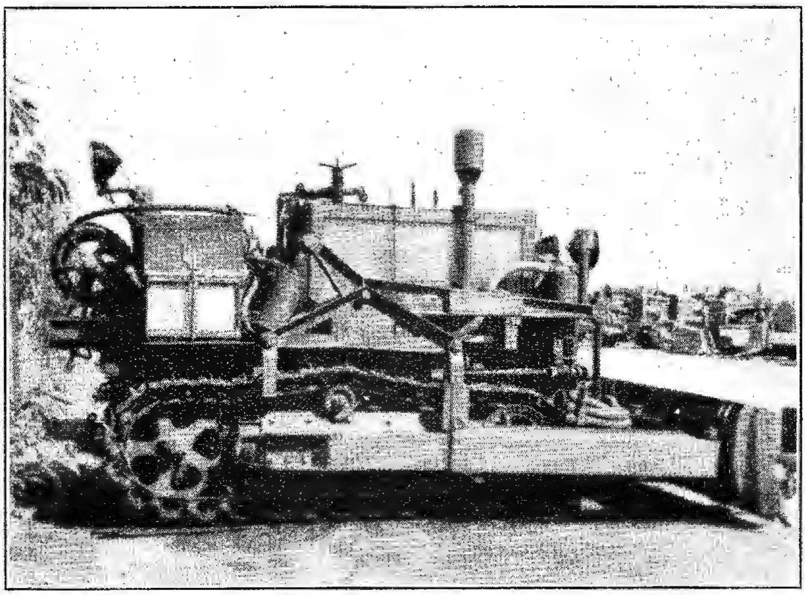
THE TRACTOR-TANKER

George M. Gowen

Chief, Fire Control, Region 5

The use of water in quantity for fire suppression and mop-up has been limited to cases where an available water supply was sufficiently close to the fire edge to permit the use of portable power pumps, or where roads or flat country permitted tank trucks to move along the edge of the fire. In numerous cases, as brought out in boards of fire review, a fire could have been suppressed in its early stages or its escape after corral prevented if pumping equipment could have been used on the fire line.

Tractors and trailbuilders have demonstrated their mobility in many types of topography in connection with logging, road building, and in fire-line construction. The efficacy of water in fire-suppression work, when available in adequate quantity, in the right location

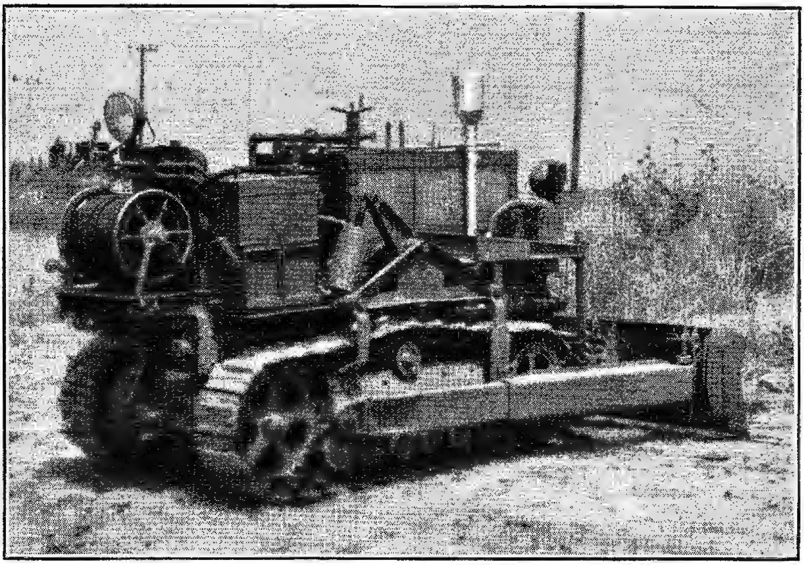


Side view of tractor-tanker, showing general assembly.

has long been recognized. Why then not combine the two, a tractor for mobility in rough country and a tanker for water supply? Accordingly, such equipment was designed and an experimental unit combining the tractor, trailbuilder, and the tanker constructed.

The tractor used was a "35" Cletrac, 1934 model, equipped with an Isaacson trailbuilder. The trailbuilder was one of the 14 made available for fire-fighting purposes during the 1937 fire season.

A 140-gallon water tank is located above the tractor engine, 6 inches vertical clearance being provided. The tank is built of heavy sheet metal, well shielded with corner angles and covered with wire mesh. It is rigidly supported by channel uprights from the tractor frame and securely held in place by front and rear X-bracing. A



Quarter view showing water tank mounted over engine and hose reel on rear deck.

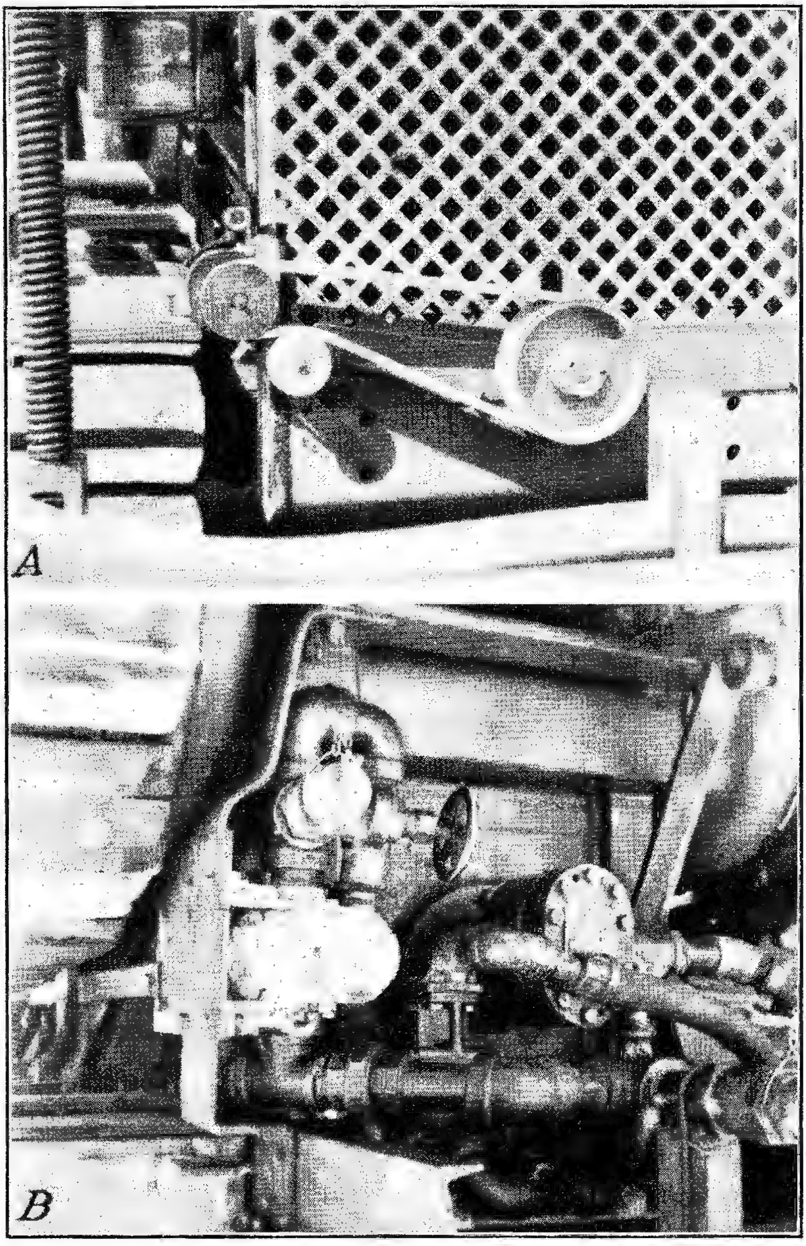
⅝-inch pipe, taking water from the extreme bottom of the tank, provides an auxiliary circulating water supply to the radiator, preventing overheating of the engine under adverse conditions of operation. The suction line to the pump extends up through the bottom of the tank about 1½ inches, preventing the complete draining of the tank, thereby always keeping sufficient water for circulation through the radiator. Located on top of the water tank at the rear is a quick opening dump valve which will completely empty the tank in 8½ seconds in cases of emergency when the load must be lightened to get out of difficult or dangerous locations.

The high-pressure pump is a type Y Pacific Pump pumper, ruggedly built and designed to turn over at 4,000 revolutions per minute. The pump is located at the rear of the tractor and driven by a line shaft secured next to the tractor frame. The shaft is powered by a belt and V-type pulley takeoff from the front of the crankshaft This pump shaft is controlled by a light clutch mounted directly behind the V-type pulley (see illustration).

A line reel, capable of carrying 200 feet of 1-inch high-pressure discharge hose, is mounted on a suitable frame behind the driver's seat. Water may be discharged through any length of hose or from the driver's seat while the tractor is moving or stationary. Four lengths of suction hose (32 feet), carried on brackets around the front of the tractor are provided for refilling the tank.

The performance tests of the pump gave the following results:

Discharging through a ⅛-inch nozzle, with a pressure of 165 pounds per square inch, emptied the 140-gallon tank in 42 minutes, throwing an unbroken stream 48 feet. Discharging through a ¼-inch nozzle, with a pressure of 100 pounds per square inch, emptied, the tank in 20 minutes, throwing an unbroken stream 60 feet. Pumping from overboard and discharging through a 7/16-inch nozzle, will throw an unbroken stream 45 feet at 125 pounds pressure. Using four lengths of 1½-inch diameter suction hose, length 32 feet, the pump will re-



(a) V-belt drive from front end of crank shaft; (b) close-up showing engine pump (left) and water pump (right) mounted on rear of tractor.

plenish the tank at the rate of 65 gallons per minute from a suction head of 18½ feet.

In making the water installation on this tractor it was necessary to redesign and relocate several standard parts such as the gas tank, engine hood, air cleaner, etc. The driver's seat was raised a few inches and the old supports were replaced by new 4-inch channels, which also support the gas tank and live-hose reel at the rear. With the tank and other apparatus in place the operator's line of vision was decreased only 2 feet in a horizontal plane.

In preliminary tests the complete unit, with tank filled, negotiated without difficulty a 76-percent slope on a smooth grass-covered incline.

The following costs apply to the experimental construction, which would be expected to be materially higher than that for subsequent units:

Labor:	
591½ hours at $1.30	$768.95
9½ hours at $1.65	15.68
Material (exclusive of pump)	78.15
Type Y Pacific pump	130.00
Procurement and handling	15.63
Total	1,008.41

In addition to use for applying water on an active fire front or on mop-up of smoldering heavy fuels, the tractor-tanker will be valuable in other respects. Backfiring may be done more promptly and safely with a tractor-tanker standing by to cool down the flames, catch slop-overs, or wet down the outside of the line. When in use as a tractor trailbuilder, actually building fire line, a nozzle man may cool down the fire with a stream of water, thus allowing the operator to work his machine right up against the fire. The extra volume of water available in the bottom of the water tank circulating through the radiator also permits the tractor to work closer to the heat of the fire without overheating and consequent damage or loss of efficiency. Because of the excessive danger of crowning and the extreme risk that the men may be trapped, spot fires in brush country frequently cannot be attacked immediately. The tractor-tanker, however, choosing the proper angle of approach, can go through the brush to the spot fire with safety. Arriving at the spot fire, the water supply can be used to cool down the flames and the trailbuilder can construct a line around the spot showing in burning material, all within a few minutes, leaving the fire to be patrolled and mopped up by the forces that may follow readily over the mashed-down brush in the path of the tractor. The unit may then go to other spots on the fire where it is needed for line holding, backfiring, line construction, or mop-up.

Because of heavy normal fire occurrence and a large area of machine chances, the unit was placed on the Shasta Experimental Fire Forest for trial under actual fire conditions. It performed very satisfactorily on the few fires that occurred within the accessible zone. During the 1938 fire season it has been in service again to further prove its value.