October 1965

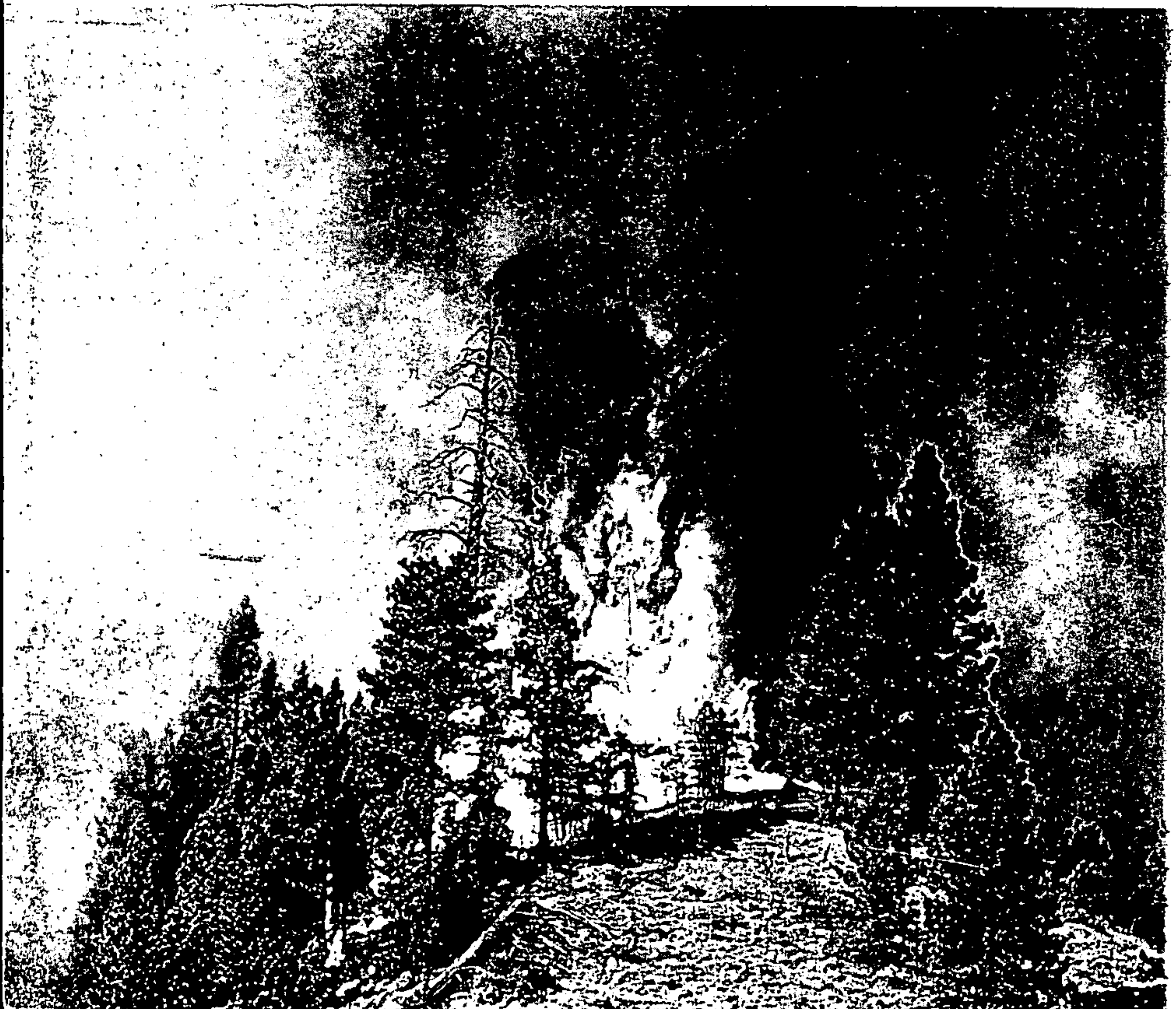
Vol. 26, No. 4



# FIRE CONTROL NOTES



U.S. Department of Agriculture
Forest Service



# FIRE CONTROL NOTES

*A quarterly periodical devoted to forest fire control*

## CONTENTS



**COVER — How would a fuel break affect this fire?**
**See story on p. 3.**

**(NOTE—Use of trade names is for information purposes and does not imply endorsement by the U.S. Department of Agriculture.)**

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D.C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (Sept. 16, 1963).

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, 20 cents a copy, or by subscription at the rate of 75 cents per year, domestic, or $1.00, foreign. Postage stamps will not be accepted in payment.

# VALUE OF A TIMBER FUEL BREAK—THE WET MEADOW FIRE

EUGENE E. MURPHY *and* JAMES L. MURPHY[1]

How effective are fuel breaks[2] in northern California timber country? On July 5, 1962, a fuel break on the Stanislaus National Forest (fig. 1) helped stop the Wet Meadow Fire at 23 acres. Although not a conflagration, it was the first sizable fire on the 40,000-acre Duckwall Conflagration Control Unit. Here Stanislaus National Forest personnel and fire researchers from the Pacific Southwest Forest and Range Experiment Station are studying the prevention and control of conflagrations by fuel modification through integrated land management.

**Figure 1.—A planned fuel break, cleared as part of the Duckwall Conflagration Control Project, extended along the ridge at the head of the canyon where the fire was located.**

## *VALUE OF A FUEL BREAK*

Nine miles of fuel break constructed along the main ridge stopped the Wet Meadow Fire at 23 acres. Without the fuel break, the fire would have crossed the ridge into heavy brush and burned at least 60 more acres (fig. 2). About $18,000 in suppression costs may also have been saved. Thus, the $10,300 expenditure for constructing the fuel break was justified.

**Figure 2.—The fire burned fiercely in the thick brush as it started up the steep slope and headed for the ridge where the fuel break was located.**

## *ENGINEERING FUEL BREAKS*

Local weather as well as topography resulted in a "pull and push" of the Wet Meadow Fire toward a prominent knob and a saddle. The inertia of the fire caused it to "lick over" the fuel break and to throw spot fires at these two points. The fire burned fiercely although it was only a high fire danger day (fig. 2). Erratic local winds were an important cause of the fire's behavior. Fuel breaks in timber must be widened at critical pressure points. Stocking may have to be reduced in timber country because the flames tend to flash through crowns at the edge of a fuel break.

An old cabin on private land was in the path of the Wet Meadow Fire. Though it was within the fuel-break system, brush and debris had not been cleared. Ten men took nearly one-half hour to build a fireline around the cabin. During extreme fire danger, the fire would have burned the cabin and swept across the ridge.

During the summer following the fire, private property owners on the Duckwall Unit were contacted. They were encouraged to help complete the fire-barrier system (with partial Federal financing through the Agricultural Conservation Program if desired) or to grant the Forest Service a fuel-break easement. The fire helped show landowners the importance of fuel modification, and they participated wholeheartedly the first year. The cabin incident also stressed the need for hazard reduction at other critical points, such as at campgrounds and along roads.

---

[1] Respectively, District Ranger, Mi-Wok Ranger District, Stanislaus National Forest, Calif., and Research Forester, Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.

[2] FUEL BREAK—a wide strip or block of land on which native vegetation has been permanently modified. Fires that burn into a fuel break can be readily controlled because they will be of lower burning intensity and will offer less resistance to control than native vegetation.

### *MAINTENANCE OF FUEL BREAKS*

Fuel breaks must be maintained to remain effective. The PSW Station researchers have begun a series of studies to determine the cost and effectiveness of various herbicides for control of undesirable regrowth and of soil sterilants for maintaining firelines within fuel breaks. Optimum rotation and cutting cycles for timbered fuel breaks and costs and schedules of TSI work are also being studied.

### *FUEL BREAKS NEED FAST, STRONG ATTACK*

The Wet Meadow Fire showed that fuel modification must be combined with fast, strong attack by an efficient fire control organization experienced in constructing fuel breaks. Under severe burning conditions the fire would have hit the ridge in 15 minutes. Quick reconnaissance, probably by aircraft, would have been needed to positively locate the fire and to report its condition. Air tanker attack with 15-minute traveltime would have been required to help keep the fire from crossing the fuel break. Quick followup by ground crews would have been necessary. Traveltime for the nearest ground crews was 40 minutes. Hence, access roads must be improved, and attack crews and equipment may have to be relocated during high fire danger.

### *LAND DEVELOPMENT*

Water developments to supplement the many miles of grass-covered fuel breaks would help utilization by livestock. They would also furnish water for fire control. Road and trail construction and maintenance would also facilitate access.

### *SUMMARY*

A combination of fuel modification, fast, strong fire attack, and land development is necessary to control conflagrations in northern California timber country.

---

## *IMPROVED DISPATCH PLANNING*

HARLEY E. RIPLEY, *Dispatcher*
*Shasta-Trinity National Forest*

As air tankers, helicopters, and other new tools are added to fire control, and as wild land resource values rise, initial-attack fire dispatching becomes more complex and requires quicker action.

The Shasta-Trinity National Forest uses planned area dispatching for man-caused fires. During the 1961-64 period, planned, prompt, aggressive dispatching helped hold hundreds of fires at small acreages under difficult burning conditions. These include individual and group man-caused fires, where starts occur without warning. Lightning storms usually give some warning, so the rapid dispatching allowed by the planned area dispatch system is not usually needed for lightning fires.

The system can be used with decentralized Ranger District dispatching or with centralized Forest dispatching. However, the larger the dispatching workload, the more attractive planned area dispatching becomes.

### *SHASTA-TRINITY AREA DISPATCH PLANNING*

1. Three fire danger rating ranges and related plans applicable to conditions on the Forest are established. In the Region 5 fire danger rating system, we chose the burning index as the desired unit of measure. Definitions of the plans follow:

A. **Green plan.**—History shows the normal initial attack force (the nearest two or three crews) have controlled fires with no escapes. The burning index is 0-11 (on a total scale of 100 points).

B. **Orange plan.**—History shows some fires escape initial attack. The burning index is 12-18.

C. **Red plan.**—All-out effort is needed to control fires. The burning index is 19 and above.

2. Logical initial attack areas are established and outlined on the Forest map, and the areas are numbered or lettered for easy identification. Preattack planning blocks are used to avoid the confusion resulting from use of two sets of blocks. We often group several blocks to form initial attack areas where similar action applies to two or more blocks (fig. 1).

3. Planned initial attack and followup are developed for each area; this includes any cover needed for vacated stations. The district rangers and the central dispatcher collaborate very closely in this phase of the planning.

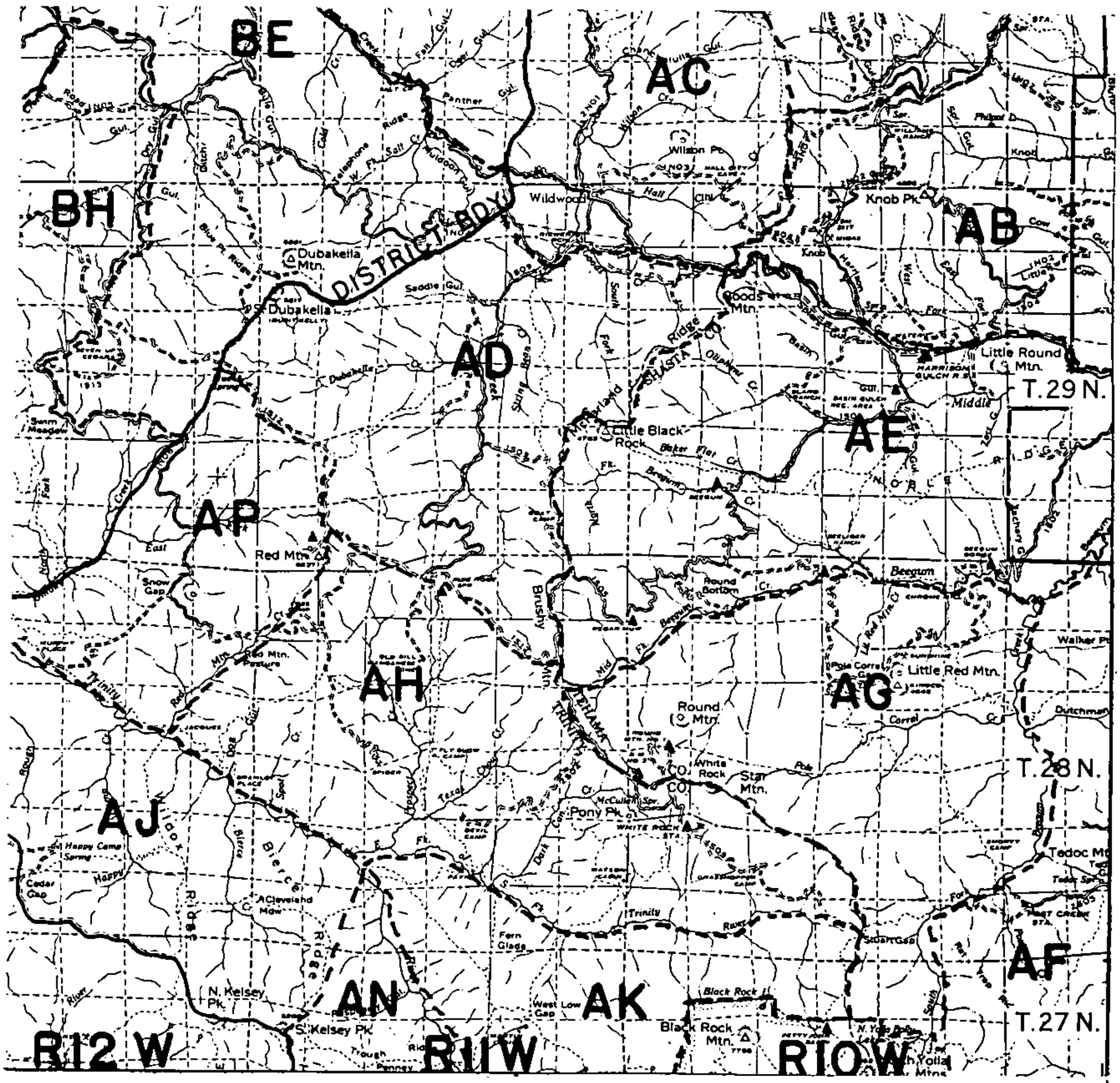
A dispatch plan is made for each area, for the three brackets of fire danger. The manpower and equipment moves are in two categories (fig. 2).

Category 1 includes manpower and equipment available to the Districts and cooperator forces. Category 2 covers such items as air tankers, smokejumpers, helicopters, and State Division of Forestry crews and equipment that are more easily contacted by the central dispatcher.

## ACCESSIBILITY OF PLANS

After the plans are made, they must be widely distributed to all individuals and crews involved. In the central dispatcher's office they can be summarized on 5- by 8-inch cards; Kardex or Unisort cards are quite suitable. A master index card must be set up for each plan (green, orange, and red) to facilitate sorting the card for the block in which the fire is reported.

Figure 1.—Solid black lines indicate Forest and District boundaries. Broken black lines separate blocks. The first letter indicates the District, the second letter the block. (Area dispatch plan map)



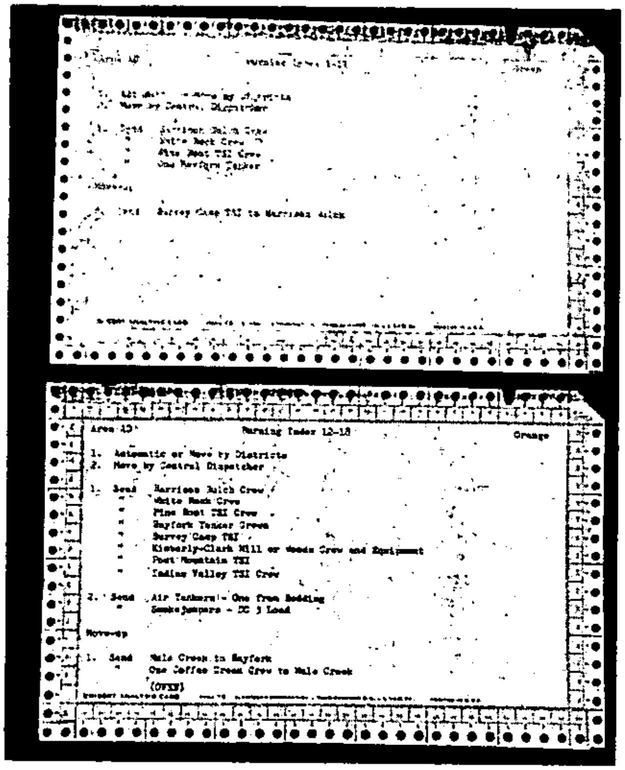


**Figure 2.—Sample preplanned attack plan for Shasta-Trinity National Forest.**

Each crew or individual should have an abbreviated plan and a map showing his assignment at the various fire danger locations and levels. The abbreviated field summary can be carried in a pocket notebook, with dictionary-style tabs to identify areas and color codes for various levels of fire danger. Some Districts have modified desk-top pushbutton alphabetical directories to indicate areas and activity levels.

### *UTILIZATION OF PLANS*

When a fire is reported and the location determined on the dispatcher's string map, he announces the block letters and map location on the radio by saying, for example, "We have a fire in Block AD, Township 29 N., Range 11 W., Section 15; the dispatch plan is green." The dispatcher then rolls category 2 items as needed and checks with the District to be sure all category 1 action has started.

The District clerks check the plan for the designated block, and then start action on the District.

Men going to the fire check field copies of the plan. As the crews start to roll they announce to the fire or their planned cover position that their radio is on and in service. They later announce their arrival at the fire.

When the fire boss is sure the fire can be controlled with the forces that have arrived, he informs the dispatcher, who will hold or turn back forces that have not yet arrived.

The planned moves, which involve many people and much equipment in the moderate and high fire danger categories, may be altered when the central dispatcher or a qualified fire boss deems it advisable. The plan is to keep men and equipment rolling toward a reported fire until control is assured.

The advantages of this "instant" dispatching over the old one-at-a-time method are greatest on a large area with a heavy, diversified workload. However, this system will not eliminate the need for a competent, experienced dispatcher who must direct all actions of this system.

---

## *INEXPENSIVE REFILL DEVICE FOR SMALL TANKERS*

RAY MILLER, *Area Forester*
*Idaho State Forestry Department*

The Idaho State Forestry Department uses numerous small tankers for initial attack on forest and range fires. These units are often operated independently of mother tankers and far from water pumping facilities.

Refilling equipment is necessary to permit continuous use of these pumpers on individual fires. An auxiliary pump, a suppression pump, or a quick-refill attachment can be used. The high-pressure, low-volume pumps mounted on the tankers are generally not satisfactory because of the long time necessary for filling and the poor suction of many low-volume pumps. Auxiliary high-volume pumps can be carried with the pumper for filling; however, the auxiliaries are expensive, and the added weight is undesirable.

The "quick-refill," using the venturi-tube principle, has been the best means of refilling tanks. The refills are small, light, and pick up much water. The cost of commercial refills, complete with accessories, is $20 to $40.

Refills presently used by the Idaho State Forestry Department are compared in table 1.

TABLE 1.—*Cost and water pickup of quick-refill venturi-tube types*[1]

| Model | Approximate cost with accessories | Water pickup |
|---|---|---|
| | *Dollars* | *Gal./min.* |
| Hurst | ([2]) | 13 |
| Bean | $30 | 26 |
| Penberthy | 20 | 9 |
| M-1, ⅛"[3] | 8 | 20 |
| M-2, 3/32"[3] | 8 | 16 |
| M-3, 5/32"[3] | 8 | 8 |

[1] Input: 4½ gal./min., 300# pressure, 300 feet ½-inch-i.d. hose, Wanner pump, 1½-inch-i.d. discharge hose.
[2] Unknown.
[3] Orifice diameter in jet.

In use, ½-inch hard line hose is attached to the refill with the swivel joint (fig. 1, item 13), and the filler hose is attached to the opposite end. The entire refill is placed in the water source, and the end of the filler hose is put into the storage tank. The pump is started as in normal operations, and the tank is filled.

The M-1, M-2, and M-3 units are shop-built refills similar to the one shown in figure 2. The only significant difference between the units is the size of the hole in the jet. The hole size can be varied to fit pumps of various capacities. Results obtained from all units of these refills during the 1964 fire season were satisfactory.

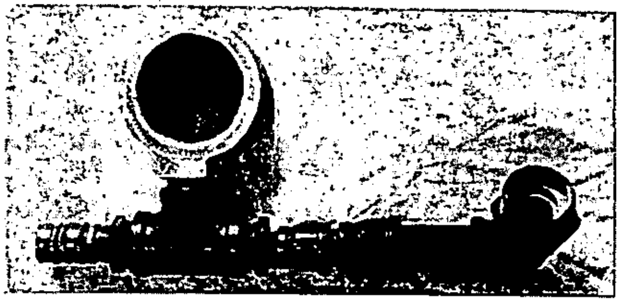


**Figure 2.—Shop-built refill.**

These shopmade units cost less than $7 and require less than 1 hour to build. They should be painted with a high-grade epoxy paint to protect the parts from corrosion. The following items, used in the fabrication of these refills, are numbered according to the numbers shown in figure 1.

| Item No. | Description | Cost |
|---|---|---|
| 1. | 1" brass-close nipple | $0.51 |
| 2. | 1" 90° elbow | .16 |
| 3. | 1" × 2" 3" nipple | .07 |
| 4. | 1" ¾" bell reducer | .17 |
| 5. | ¾" close nipple | .04 |
| 6. | ¾" ½" bell reducer | .17 |
| 7. | ½" close nipple | .03 |
| 8. | ½" × 1" bushing | .09 |
| 9. | 1" "T" | .23 |
| 10. | ¾" × 1" bushing | .09 |
| 11. | ½" airhose coupling | .55 |
| 12. | ¾" HT-¾" and ½" pipe adapter | .25 |
| 13. | ¾" HT—double female swivel | .25 |
| 14. | 1" brass close nipple | .51 |
| 15. | Intake screen (Western Fire) | 3.50 |
| | Total | $6.62 |

(Continued on page 9)

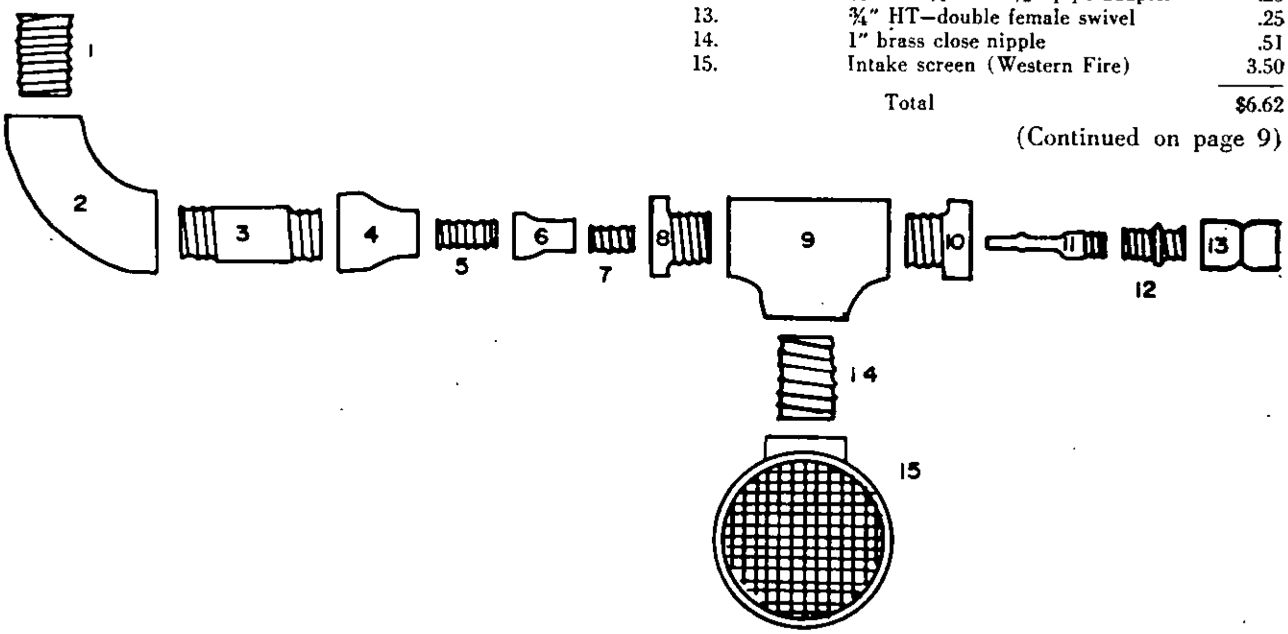



**Figure 1.—Diagram of assembly.**

# BACKPACK MIST BLOWER AS A FIRELINE BUILDER

JOHN F. WELSH, *District Ranger,*
*Buffalo District, Ozark-St. Francis National Forest*

The backpack mist blower has been an effective forest fire fighting tool in the pine-hardwood and hardwood types of the Arkansas Ozarks. The machine was designed for application of liquid herbicides and insecticidal dusts, but without special adaptations it also has been used for airblasting firelines. The blower is used primarily to remove fine, loose fuel from the proposed fireline.

Most of this material is hard to move effectively with handtools, and even when a plow can be used safely, most of the material falls in behind the machine. A properly directed airblast quickly moves most of the material. Effectiveness depends on many factors, including quality, quantity, size, and compactness of fuels; steepness of terrain; and rockiness of soil.

### *Earlier Uses of Blowers*

A wheeled blower was developed in the late 1950's to clear hardwood leaves from firelines in Missouri.[1] In 1962, a backpack mist blower was used to apply water in fire suppression.[2] However, use of the backpack mist blower for airblast line building is apparently new.

### *Site Conditions*

Arkansas Ozark fuel types are medium to high in both rate of spread and resistance to control. Hardwood leaves usually are the most conspicuous and troublesome component. Soils are thin and rocky. Topography consists of broad, flat ridgetops and rough, steep drainages, with vertical bluffs not uncommon. Rocks and steep slopes preclude wide use of plow units, and steep terrain reduces the utility of a wheeled blower. Because of rising watershed, timber, and wildlife values, slow and inefficient fire suppression with handtools outside the plowable area can no longer be tolerated. The backpack mist blower is one good answer to the difficult fuel, soil, and topographic conditions.

[1] Nichols, J. M., and Paulsell, L. K. A new idea in firefighting: air blast line building. Univ. Mo. Agr. Expt. Sta. Bul. 725. 7 pp., illus. February 1959.

[2] Lashley, O. L. Backpack mist blower for fire suppression. Fire Control Notes 23(4): 107, illus. October 1962.

### *Instrumentation*

The mist blower used to suppress fires on the Buffalo District of the Ozark-St. Francis National Forest is the Model KWH-75, manufactured by Kiekens Whirlwind of the Netherlands (fig. 1). It has an air-cooled, two-cycle engine with 6,000 r.p.m. The fuel tank capacity is 0.6 gallon. The blower was not basically modified; however, the unneeded herbicide tank, valves, tubing, etc., were removed to reduce weight. The weight of the blower without the mist tank is 35 pounds. The blower delivers 435 cubic feet of air per minute through a bent metal tube, under the operator's right arm, into a flexible hose about 5 inches in diameter and 3 feet long. The flexibility of the airhose permits the operator to direct the jet of air.

### *Personnel*

Recommended personnel for building firelines with the mist blower consist of a line locator, a blower operator, and a followup crew. The line locator also breaks up matted fuel beds with a fire rake (Council Tool). The blower operator constructs line of the desired width and cleanness by varying his speed of advance and the degree of lateral swing of the air nozzle. The followup crew usually consists of one to four men, depending on the amount of matted or coarse fuel, the difficulty of holding the line, and, of

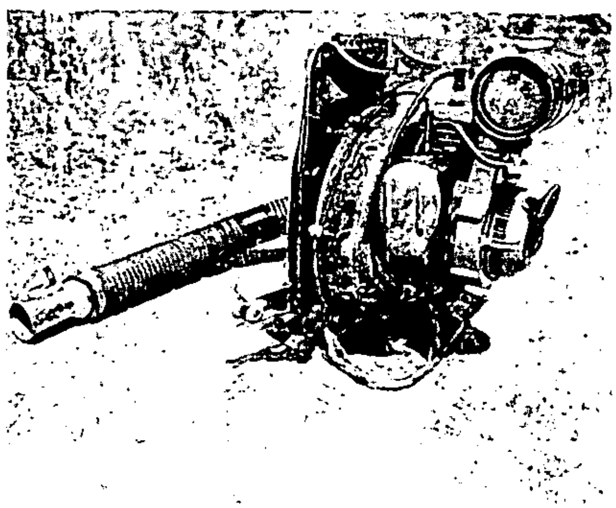


**Figure 1.—The stripped-down backpack mist blower ready for action.**

course, the availability of manpower. Trained followup crewmen serve as relief blower operators.

For each man-hour, a trained crew can construct 18- to 20-inch firelines about 13 to 25 chains long, depending on amount of fuel, slope, rocky soils, etc. On February 12, 1962, a Class 4 fire day, 14 men and 2 blowers controlled the Koen Fire at 129 acres. Within 2½ hours after initial attack, they built and held 190 chains of fireline at the rate of 5 chains per man-hour. Blowers have since been used on all fires except those that were controlled by other means before a blower could be dispatched (fig. 2).

### *Summary*

Some advantages of the backpack mist blower are:

1. Low cost: about $300.
2. Versatility: The mist blower can be used in timber management and other functions outside the fire season.
3. Portability in rugged terrain: The blower can be used where a man can walk safely.
4. High effectiveness in clearing fuel between small rocks where handtools cannot reach (fig. 2).
5. Speed: Fireline is built almost as fast as a slow walk.
6. Low skill requirements: Inexperienced men learn to use it quickly.

Some disadvantages of the blower are:

1. Ineffectiveness in coarse or matted fuels and in dense, low brush.
2. Inability to build fireline down to mineral soil.
3. Possibility of mechanical failure.

Special safety precautions to be observed in using the mist blower in fireline construction are:

1. Protect eyes of blower operator and nearby workers from flying particles.
2. Be sure of footing while carrying blower.

**Figure 2.—Fireline cleared by the mist blower through an area too rocky for plowing or effective use of handtools.**

3. Pick escape route to prevent heavily laden blower operator from being trapped by fast-moving fire.

Experience indicates safe, dependable, effective operation can be achieved rather easily. Advantages of fireline construction with the mist blower definitely outweigh disadvantages under the conditions described. Therefore, the backpack mist blower should be a powerful new fire suppression tool under certain fuel, soil, and topographic conditions.

---

**Refill Device**—(Continued from page 7)

The refill shown in figure 1 is designed for use with a 1-inch filler hose. If 1½-inch filler hose is used, item two can be exchanged for a 1-inch street elbow and item one for a 1- by 1½-inch brass bushing (fig. 2). Use of a 1-inch filler hose slightly reduces the volumes, according to table 1, that are picked up by the refill. The surface of item one that contacts the gasket of the filler hose may need facing to prevent cutting of the gasket and to insure a good seal. Item 11 is the jet that provides the power for the refill. It is constructed from a ½-inch air-hose coupling. The small end of the hose coupling is filled with bronze, and a ⅛-inch hole is drilled in the center of the weld. The hole sizes may be varied according to the volume of the pump and its operating pressure. The hexagon corners of the hose coupling must be ground off in order for it to pass through the hole in item 10.

# THE EFFECT OF THE EARTH'S CURVATURE IN VISIBILITY MAPPING

C. E. Van Wagner,[1] *Fire Research Officer*
*Canadian Department of Forestry*

The profile method of drawing visibility maps has been well described in the literature, e.g., by Show et al. (1937)[2] and by Catto (1960).[3] Using good contour maps, reasonably accurate visibility maps can be drawn in the office. However, field checks are advisable. The techniques of field sketching are covered by Show et al. (1937)[2] and by Chorlton (1951).[4]

There are two variations of the profile method. In one, vertical profiles along lines radiating from the tower are plotted separately, and lines of sight are drawn to the successive ridges; the visibility information is then transferred to the radial lines on the map. In the other, use of a profile board permits the operator to plot visibility directly along the radial lines on the map without first plotting the profiles. A movable arm pivoted at the tower position is set at a different angle for each line of sight, and a vertical scale laid on its side is used to determine whether points on the other side of intervening ridges are visible.

Several sources of error in the profile method (e.g., height of trees on ridges, projection of ridges above highest contour, and doubt of exact tower elevation) are well-known, but there is one source that is not mentioned in the literature. This is the effect of the earth's curvature.

A formula is used to determine if that effect is large enough to be considered. In surveying, the vertical depression of distant points due to the earth's curvature is given in feet by $0.667\,K^2$, where K is the distance in miles. In practice, atmospheric refraction curves the line of sight slightly downward, reducing the apparent error to $0.574\,K^2$. Table 1 shows the depression in feet for distances of 1 to 20 miles. The actual errors in screening are always less than the figures given because the intervening ridge is lowered by the earth's curvature. Consider figure 1. T is a lookout tower, R is an intervening ridge at distance x from T, and P is a point at distance y from R. The dotted lines represent a flat-earth surface and the resulting plotted line of sight, the solid lines the curved-earth surface and true line of sight. The point P is screened from sight by the vertical interval between line of sight and the earth's surface; the interval is apparently greater in the curved-earth model than in the flat-earth model. The question is: How much greater?

Table 1. — *Depression due to earth's curvature and atmospheric refraction*

| Distance | Depression | Distance | Depression |
|---|---|---|---|
| *Miles* | *Feet* | *Miles* | *Feet* |
| 1 | 1 | 11 | 81 |
| 2 | 3 | 12 | 96 |
| 3 | 6 | 13 | 113 |
| 4 | 11 | 14 | 131 |
| 5 | 17 | 15 | 150 |
| 6 | 24 | 16 | 171 |
| 7 | 33 | 17 | 193 |
| 8 | 43 | 18 | 216 |
| 9 | 54 | 19 | 241 |
| 10 | 67 | 20 | 267 |

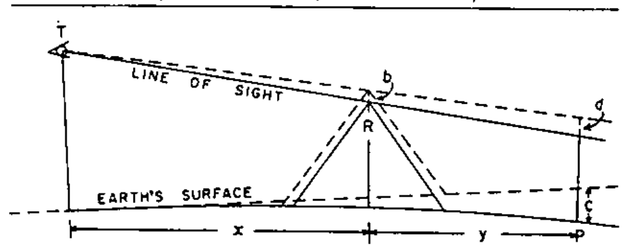



**Figure 1.—Diagram of effect of earth's curvature in visibility mapping with exaggerated vertical scale.**

The position of P is lowered by the earth's curvature an amount c, equal to $0.574(x + y)^2$. The line of sight is lowered an amount d, due to the depression of the ridge R by an amount b. But d bears to b the same ratio as the distances of P and R from T. That is,

$$\frac{d}{b} = \frac{x + y}{x}$$

but $b = 0.574\,x^2$

therefore
$$d = 0.574\,x^2\,\frac{(x + y)}{x} = 0.574\,x\,(x + y)$$

[1] The author is stationed at the Petawawa Forest Experiment Station, Chalk River, Ontario.

[2] Show, S. B., Kotok, E. I., Gowan, G. M., Curry, J. R., and Brown, A. A. Planning, constructing, and operating forest-fire lookout systems in California, U.S. Dept. Agr. Cir. No. 449. 1937.

[3] Catto, A. T. Visibility maps for fire protection. Pulp and Paper Mag. of Canada, Woodlands Rev., Conv. Issue: 4-20, 41. 1960.

[4] Chorlton, R. W. The preparation of visible area maps by field sketching. Canada Dept. Resources and Devlpmt., Forest Fire Res. Note No. 16. 1951.

The net error in vertical screening equals c — d and is always unfavorable because c is always greater than d.

$$\text{Error} = c - d = 0.574(x + y)^2 - 0.574\,x\,(x + y) = 0.574\,y(x + y)$$

The error is in feet, and the distances are in miles.

That is, the net error depends on the product of the distances from tower to point and from ridge to point; it is slight for points just past an intervening ridge regardless of distance, and substantial only for points far past a ridge. Table 2 shows the net error for a few sample configurations. The vertical errors due to the earth's curvature would be least in hilly country abounding in ridges because each would limit the line of sight for a short distance. In mountainous country the vertical errors would be small compared with the great variations in screening below line of sight, and the horizontal errors in visible area would be slight on steep slopes. *It is in fairly level topography with only a few ridges, each limiting the line of sight for a considerable distance, that the appearance of a visibility map might be considerably altered.* The effect of vertical errors would be more important on a map showing different degrees of vertical screening rather than simple visible area.

TABLE 2. — *Net curvature errors for some combinations of distances from tower to ridge and ridge to point*

| Distance | | Net error | Distance | | Net error |
|---|---|---|---|---|---|
| Tower to ridge | Ridge to point | | Tower to ridge | Ridge to point | |
| *Miles* | *Miles* | *Feet* | *Miles* | *Miles* | *Feet* |
| 5 | 1 | 3 | 15 | 1 | 9 |
| 5 | 5 | 29 | 15 | 5 | 57 |
| 5 | 10 | 86 | 15 | 10 | 143 |
| 10 | 1 | 6 | 20 | 1 | 12 |
| 10 | 5 | 43 | 20 | 5 | 72 |
| 10 | 10 | 115 | 20 | 10 | 172 |

(A potential pitfall in separating lightly and heavily screened areas with the profile board deserves mention here. Screening is understood in the vertical sense, not perpendicular to the line of sight. A negative error results if degrees of screening are marked on the movable arm, or if the width of the arm is used to separate light and heavy screening. This error is due to the exaggerated vertical scale and equals the difference between A B and A C in figure 2. The angle $\alpha$ of the movable arm is obviously the same as the angle B A C. Therefore, A B equals A C cos $\alpha$. The error amounts for instance, to 14 percent of A C when $\alpha$ is 30°, or to 29 percent when $\alpha$ is 45°.)

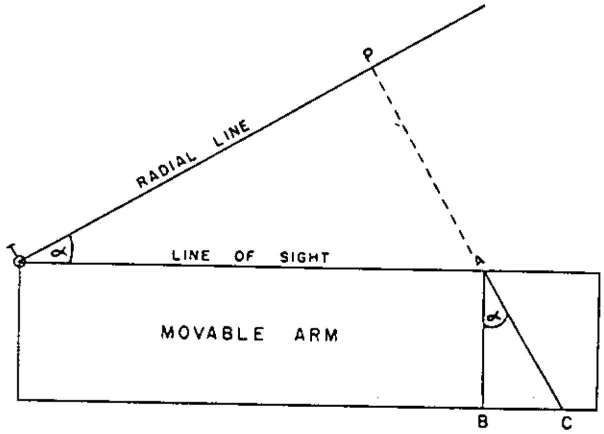



**Figure 2.—Effect of measuring degree of screening perpendicular to line of sight instead of to earth's surface. True screening is along A C.**

Whether the earth's curvature should be considered in a given job of visibility mapping can be judged by comparing some typical curvature errors in the tower area (consult table 2 or use formula) with the accuracy desired. The correction is readily made if profiles are plotted — each plotted elevation is reduced according to its distance from the tower (see table 1), and the drawn lines of sight will then be in the correct positions. If the profile board is used, a correction must be made both at the ridge when setting the line of sight and to each subsequent point as it is tested; alternatively, the upper edge of the board can be cut to the proper curve and placed tangent to the radial line at the tower.

According to the National Fire Protection Association, the two largest single property-loss fires of 1964 probably occurred at Walker Air Force Base, N. Mex. On February 13 and on March 9, fire and explosion destroyed missile launching facilities. Each incident cost about $11½ million.

# *U.S.S.R. FOREST FIRE RESEARCH AND METHODS OF FIRE CONTROL*[1]

VALENTIN G. NESTEROV, *Head Forestry Chair*
*Timiryasev Agricultural Academy, Moscow, U.S.S.R.*

U.S.S.R. forests contain 25 percent of the world's forest resources. Much attention is given to the protection of these forests from fires. An effective fire control system is the main component of forest fire research. It is used to regulate the type and amount of fire-prevention measures used throughout the country.

A system of forest fire protection was first expounded by the author in 1939.[2] As a principle of the system, we take the mathematical expression of interaction among the following components: Burning ability, fire weather, propaganda, fire-resistance characteristics of the forest, discovery and analysis of fires, and localization and suppression of fires.[3]

The fight against forest fires can be represented by a formula, with six major factors, that is perfect only when we have few fires and suppress them early. In viewing the formula, imagine two competing forces—one representing fire strength and the other fire suppression forces.

The first step in the fire control system is the division of the forest into plots—blocks of the same burning ability and, of course, of the same fire danger. This first procedure is as follows:

Neighboring plots or blocks should first be distributed into classes of burning ability.

*Class I.*—Coniferous stands on dry or fresh soils, and plantations of leaf-bearing forest on dry soil.

*Class II.*—Coniferous stands on wet and swamp soils.

*Class III*—Leaf-bearing stands on fresh and wet soils. (In some regions fresh leaf-bearing stands can be included in Class II).

Each class of forest blocks is subdivided according to fire danger into the following sections:

*Section A.*—A road is inside the section or not more than 200 meters away, or a settlement or a timber enterprise is within 5 kilometers.

*Section B.*—The nearest settlement is within 5 to 10 kilometers.

*Section C.*—It is more than 10 kilometers to the nearest settlement.

---

[1] Adapted from paper presented at Symposium on Forest Fire Research, Tenth Pacific Sci. Cong., August 1961.

[2] Nesterov, V. G. Instructions on working out a plan of fire protection measures of a forest. All-Union Res. Inst. 1940.

[3] Nesterov, V. G. Burning ability of forest and methods of its defining. 1949.

To calculate the second determinant of the system we have defined the fire danger of weather using "complex meteorological methods."

Experience gained from meteorological studies of 20,000 forest fires shows that duration of dry season, quantity of rainfall, temperature of air, vapor-pressure deficit, and windspeed are the best indices of burning ability of vegetation.

Understanding of physical processes occurring in the phenomena and the correct establishment of interaction coefficients permit us to construct the most reliable index of fire danger to forests. The general formula is:

$$T = K_1 K_2 \int F(u)du$$
$$\cong K_1 K_2 \Sigma\ (u)$$

where: $T$ = burning index;

$u$ = meteorological index for a day
$= t\ d$ where $t$ = temperature; $d$ = vapor-press deficit;

$K_1$ = coefficient representing last rainfall; and

$K_2$ = coefficient representing wind influence
= 1 for wind $<6$ meters/second (0–12 m.p.h.)
= 2 for wind = 6–10 meters/second (13–22 m.p.h.)
= 4 for wind $>10$ meters/second (23+ m.p.h.).

For example, let us see what changes occur in the burning ability of a forest with changes in the simplified complex index, $\Sigma\ (t\ d)$. Here one must consider the sum of products resulting from the multiplication of temperature of air, $t$, by vapor-pressure deficit, $d$, at 13.00 each day beginning from the last rainy day and ending on the day when the burning index is calculated. This determinant changes as follows:

*Class I.*—The index is less than 300 degree-millibars. Fires are impossible.

*Class II.*—500–1,000 degree-millibars. Weak surface fires can appear.

*Class III.*—1,000–4,000 degree-millibars. Strong surface and weak crown fires are quite possible.

*Class IV.*—More than 4,000 degree-millibars. Generally dangerous crown fires can result. Burning ability is very strong.

On the basis of these classes the Central Institute of Weather Forecasting publishes daily information maps
(Continued on page 14)

# *FIREFIGHTING FARM LABORERS*

MORRISON "JIM" JAMES, *Forester,*
*Division of I&E, Berkeley, Calif.*

Forest Service fire control officers fighting wildland fires in California have seen their initial attack crews fail to stop a fire. Fast followup was required to contain the fire in the first burning period. When California is hard hit by simultaneous fires or by a large fire such as the recent Coyote Fire, the supply of local pretrained and organized crews may be exhausted. The Forest Service must then rely on crews recruited from outside sources.

### *Reserve Labor Supply*

The City of Porterville, headquarters for the Sequoia National Forest, is in an agricultural area where farm labor requirements are only intermittently great. A labor force of several hundred men, primarily of Spanish-American extraction, lives in and near Porterville. The Forest Service has usually obtained pickup labor by contacting one or more of three labor contractors. The contractors, after assembling the desired number of men, were hired as labor leaders. Fortunately the normal fire season coincided with a period when farm labor requirements were low.

Individual laborers were hardened physically and were skilled in the use of handtools; however, many had physical defects and many could not speak English. In addition, mobilization was slow, turnover was great, and teamwork and prefire training were lacking.

The three contractors, all of Spanish-American extraction, were known by reputation and experience to be reliable, conscientious, and anxious to help the Forest Service and the farm laborers they worked with. They were classified as labor leaders and were asked to select one man as a crew leader for each 25-man crew and one man as a squad leader for each 5 to 7 laborers. The crew and squad leaders were chosen, subject to approval of the Forest Service, and a graduated pay scale was worked out, commensurate with the responsibility of the position.

Each labor leader organized three or four 25-man crews. Labor leaders and crew leaders must be able to speak English and Spanish and must attend a Forest Service training session. Crew leaders are required to have previous fire experience and a current physical examination on file with the Forest Service. Alternate squad leaders are designated to save time in making up crews. The crew man must be accepted as a mem-

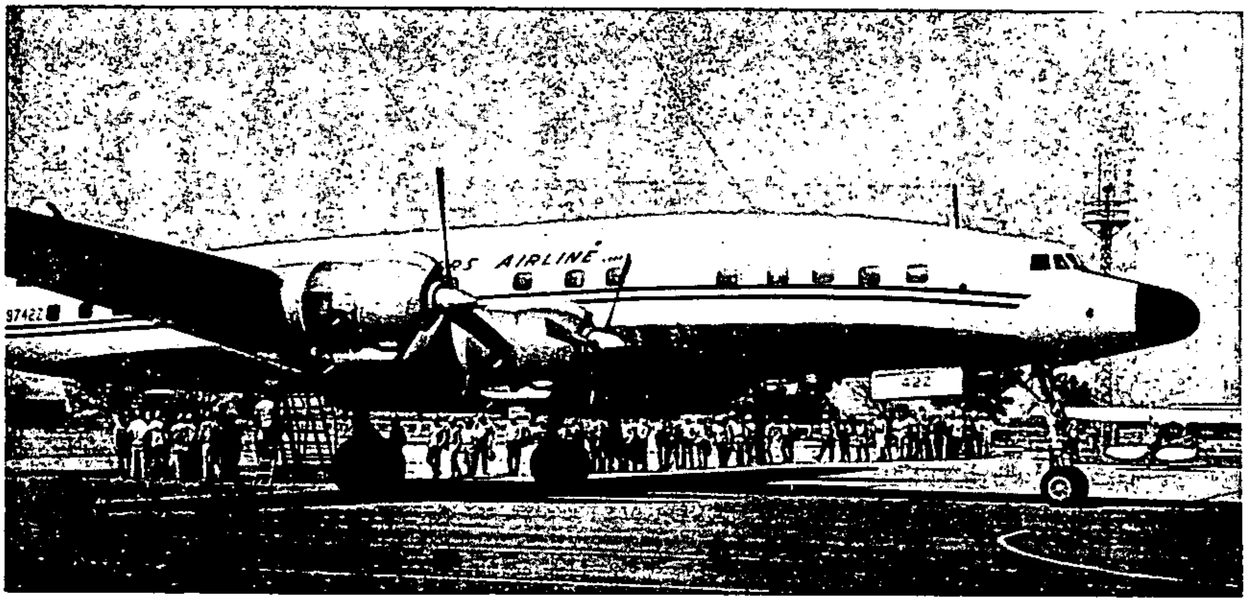



Figure 1.—Porterville-organized fire crew boards chartered plane for transportation to Coyote Fire. (Courtesy of Porterville Recorder.)

ber of a crew and have a record of a recent physical examination on file. While not necessarily desirable, crew men are permitted to shift between crews. This is done primarily to reduce the time required for roundup and mobilization.

Each man on the approved list is issued a card showing his name, address, crew affiliation, and highest qualified position. This card must be presented before he is hired for each fire. The card expires when he is due for his next physical examination.

### *Training*

Training sessions are conducted by the Forest Service and the California Department of Employment. Attendance is required of all leaders. Emphasis is on Forest Service fire organization, crew organization and function, safety, rules of conduct, and requirements for employment. The curriculum is designed to equip the native leaders to provide for crew welfare, integrity, and safety, on the line and in camp. They are expected to work under the direct supervision of a qualified Forest Service fire crew boss and operate the crew as a well-organized, skillful hand crew. The leaders do receive some training in firefighting techniques and skills. However, most instruction is on-the-job training. A crew may be suspended from the hiring list for failing to do a good job.

### *Results*

Results have been good. About 350 trained and well-organized men are available from this source and can be bussed or flown to a fire (fig. 1). The California Department of Employment office in Porterville has the personnel and facilities to screen and sign these men in a minimum of time, day or night. During the 1964 fire season these crews were called on to fight 16 fires on seven National Forests. They worked 10,140 man-days.

---

**U.S.S.R.**— (Continued from page 12)

showing meteorological indices of the burning index of our forest areas, and issues bulletins forecasting the burning index of forests for 3 days, a synoptic period of about 1 week, and 1 month. This service enables us to discover fire at the initial stage of its development and to arrive quickly—the most important needs in firefighting.

The third point of the system requires improvement of propaganda concerning precautionary measures against fire and rules on careless handling of fire sources in forests. We use widely the extensive opportunities provided by the press, cinema, television, education, etc. We have found it useful to determine fire-prevention rules for special forestry activities—forest cleaning works, timber exploitation areas, forest settlements, etc.

The fourth point of the system involves strengthening the fire-resisting characteristics of the forest. It is of great value to clear logging debris and dead trees, to plant fire-protection forest belts, to sow fireproof grasses, to build firebreaks, to construct communication lines and roads, and to properly distribute fire-lookout towers, landing fields, and fire-chemical stations. To obtain the most efficient fire prevention, cuttings, mineralized zones, wet and grass barriers, wet forest zones, rivers, streams, and roads should divide forest areas into isolated blocks as small as possible. This is my "principle of an exclusive circle of barriers."

The fifth factor of the system is to discover forest fires as quickly as possible and to determine their characteristics. The best results are achieved by combining ground and air watch services. Great attention must be given to the use of photoelectric cells, radar, and other technical achievements.

Localization and suppression of fires is the sixth part of the system. According to my proposal different types of fire-chemical stations with motor and horse-drawn transport were organized. The following comparative coefficients indicate the speed of localization and suppression of forest fires, with different suppression techniques:

1. Digging a trench around a fire with handtools—1.
2. Horse plowing in two furrows—15.
3. Horse plowing in one furrow—30.
4. Tractor plowing—60.
5. Creation of chemical protection belts using portable sprayers—3.
6. Liquidation of fire by hand pumps—9.
7. Suppression of fire by flamethrowers—10.
8. Liquidation of fire by chemical solutions using portable sprayers—12.
9. Liquidation of fire by water using motor pumps—20–30.
10. Development of protective chemical and mineralized zones using tractors—45–60.

The fight against forest fires from the air also gives good results.

# INDEX, 1965

(Numbers in parentheses are issue numbers)

C V KOMAREK
TALL TIMBERS RESEARCH INC
ROUTE 1, BOX 110
TALLAHASSEE FLA

U.S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C. 20250

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF AGRICULTURE