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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 11 Number 2

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals 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, 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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Forest Service, Washington, D. C.

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CONTENTS

NEW FIRE PUMPERS TESTED

ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER

Region 5, U. S. Forest Service

In accordance with the procedure adopted for qualifying pumps as suited for forest fire service, the Arcadia Fire Control Equipment Development Center has conducted performance tests on the three portable pumps described below.

UNIT 1

This unit, U. S. F. S. Region 5 Model 47 Portable Pumper (specification revised October 1947), consists of a pump, engine, base, and carrying handles (fig. 1). It has a dry weight of 96 pounds, and its over-all dimensions are 24 inches long, 16½ inches wide, and 20 inches high.

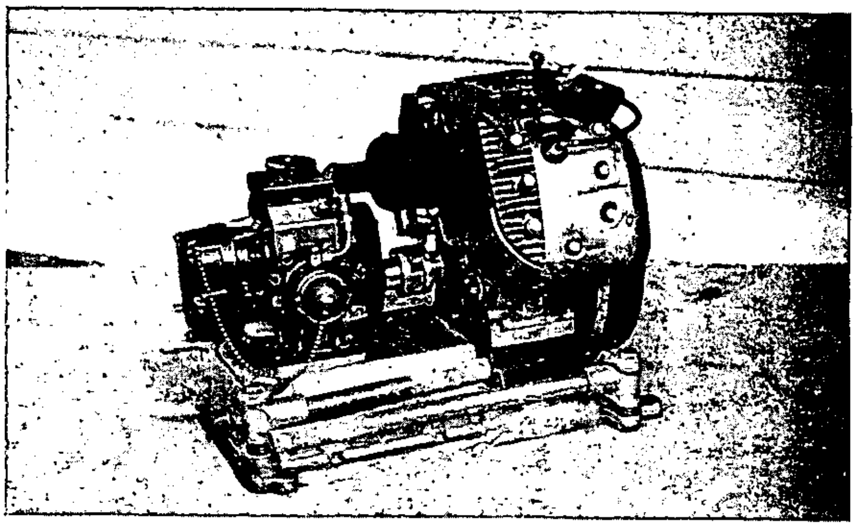

FIGURE 1.—Unit 1: U. S. F. S. Region 5 Model 47 Portable Pumper.

Performance ratings with 3-foot suction lift are as follows:

Discharge pressure (pounds per square inch):	*Discharge rate (U. S. gallons per minute)*
0 (free discharge)	25
100	22½
250	18
310	16

The engine is a single cylinder, air-cooled, 4-stroke cycle gasoline type, rated 6 horsepower at 2,700 revolutions per minute (r. p. m.), and is equipped for rope starting. Ignition is by an impulse type magneto. Fuel used is commercial grade gasoline of approximately 70 octane supplied from an auxiliary tank by fuel pump. Fuel consumption is approximately 0.5 gallon per hour when operating at normal conditions of 18 gallons per minute (g. p. m.), 250 pounds per square inch (p. s. i.), and 2,900 r. p. m.

SAE 30 detergent type oil is used in the engine crankcase, which has a capacity of 3 pints.

The pump is a positive displacement gear type with pilot gears. This particular model has aluminum end cases, monel metal wear plates, and bronze impellers on stainless steel shafts. Connection of the pump to engine is direct through a flexible coupling.

Standard accessories include the following:

- Built-in tool compartment in base.
- Guard plate on which engine controls are mounted.
- Pressure gage, 0–500 p. s. i.
- 1 gasoline tank, 4-gallon.
- 1 gasoline hose, 5-foot.
- 2 starter ropes.
- 1 oil measure.
- 1 grease gun.
- 1 can bearing grease.
- 1 spark plug (extra).
- 1 spark plug wrench.
- 1 point feeler gage.
- 1 packing gland wrench.
- 1 pliers, 8-inch.
- 1 screw driver, 6-inch.
- 1 crescent wrench, 6-inch.
- 1 crescent wrench, 8-inch.
- 2 spanner wrenches, forestry lug.

Performance of this pumper compared with the specifications, revised October 1947, as follows:

Specification:	*Test results*
Maximum weight, less accessories: 100 pounds	96 pounds.
Maximum dimensions: basal area, 3 square feet; height, 20 inches.	2.67 square feet, 20 inches.
Vacuum when new: not less than 20 inches Hg. (mercury) with unit dry and at governed normal r. p. m. specified by manufacturer.	20 inches Hg.
Vacuum after 100 hours: not less than 15 inches Hg. with unit dry and at governed normal r. p. m. specified by manufacturer.	15.5 inches Hg.
Normal output: 18 g. p. m. at 250 p. s. i. with 3-foot suction lift and at governed normal r. p. m. specified by manufacturer.	18.45 g. p. m.
Maximum output when new: not less than 16 g. p. m. at 310 p. s. i. with 3-foot suction lift and full throttle.	16.8 g. p. m.
Maximum output after 100 hours: not less than 15 g. p. m. at 300 p. s. i. with 3-foot suction lift and full throttle.	16.6 g. p. m.

Cost of the pumper complete with listed accessories, f. o. b. San Francisco, was $528 as of June 1946.

UNIT 2

Subsequent investigation toward securing a more economical unit in the same performance class has resulted in the manufacture of a cheaper model with identical performance characteristics (fig. 2).

This unit, U. S. F. S. Region 5 Model 47 Portable Pumper (specification revised July 7, 1949), is essentially the same as that shown in figure 1. The main differences are a reduction of accessories, simplified base and porter bars, elimination of the engine control guard plate, and change of materials used in the pump.

This pump has an aluminum pilot gear cover and a stainless steel shaft, but is otherwise all bronze. Where difficulty due to either corrosion or electrolytic action can be expected, the bronze unit is to be preferred.

Standard accessories include:

1 pressure gage, 0–400 p. s. i.
2 starter ropes.
1 grease gun.
1 spark plug wrench.
1 set, magneto and breaker point adjusting tool and spacer gage.
1 packing gland wrench.
1 pair pliers, 6-inch combination.
1 screw driver, 4-inch.
2 instruction books.
1 extra set of spark plugs.

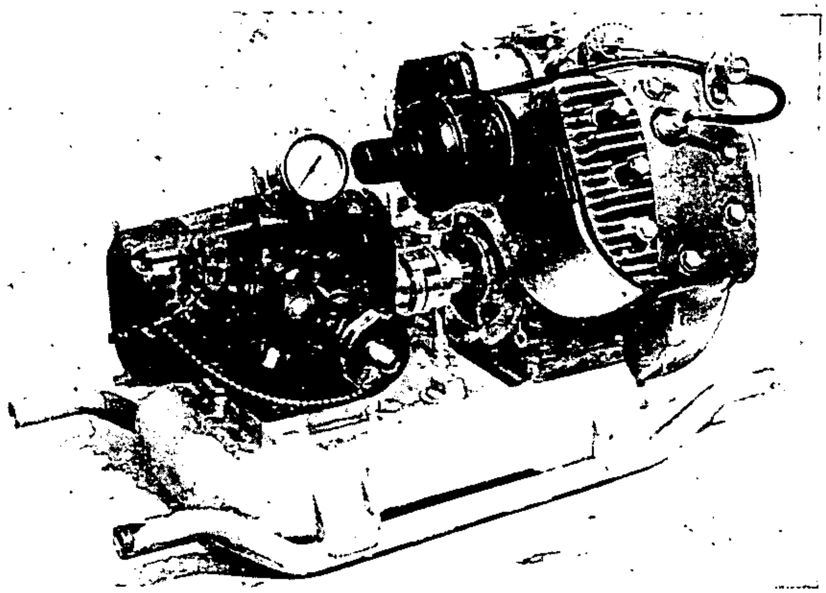

FIGURE 2.—Unit 2: Lower Cost U. S. F. S. Region 5 Model 47 Portable Pumper.

Performance of this pumper compared with the specifications, revised July 7, 1949, as follows:

Specifications:	*Test results*
Maximum weight: 130 pounds	100 pounds.
Maximum dimensions: basal area, 3 square feet; height, 20 inches.	2.67 square feet, 20 inches.
Vacuum when new: 20 inches Hg. minimum	20 inches Hg.
Vacuum after 100 hours: 15 inches Hg. minimum.	15.5 inches Hg.
Normal output: 18 g. p. m. at 250 p. s. i. minimum.	18.45 g. p. m.
Maximum output when new: not less than 16 g. p. m. at 310 p. s. i.	16.8 g. p. m.
Maximum output after 100 hours: not less than 15 g. p. m. at 300 p. s. i.	16.6 g. p. m.

Cost of the pumper, complete with standard accessories as listed, as of August, 1949, is $365 f. o. b. San Francisco.

It appears, after extensive investigation of possible applications of low-pressure fog and wet water, that a pump in this capacity range is to be recommended as being better suited for general service than units having lower discharge rates at lower discharge pressures. Details of the results of these studies are expected for release in an early issue of FIRE CONTROL NOTES.

UNIT 3

This unit consists of a pump, engine with accessories, base and carrying handles (fig. 3). It has a dry weight of 190 pounds, and its dimensions are 29 inches long, 22 inches wide, and 21 inches high.

Performance ratings are as follows:

Discharge pressure (pounds per square inch):	*Discharge rate (U. S. gallons per minute)*
0 (free discharge)	45
100	40
250	30
310	25

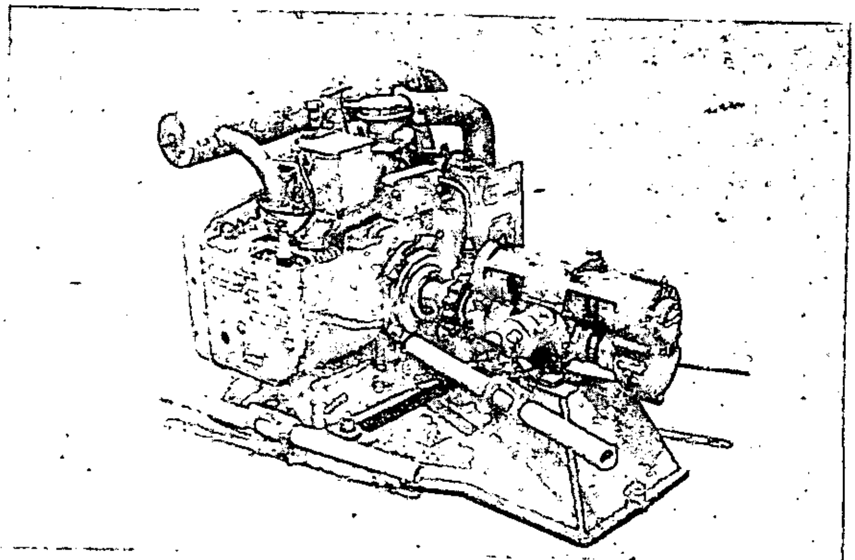

FIGURE 3.—Unit 3: U. S. F. S. Region 5 Model 49 Portable Pumper.

The engine is an air-cooled, opposed twin cylinder, 4-stroke cycle, L-head gasoline type, rated at 10 hp. at 2,700 r. p. m. and is equipped with a 12-volt electric starter-generator system provided for rope starting in an emergency. Commercial grade fuel, approximately 70 octane, is used, and is supplied from an auxiliary 5-gallon tank and fed to the carburetor by a fuel pump. Fuel consumption is approximately 1 gallon per hour when operating at normal rated load.

SAE 30 detergent type oil is used in the engine crankcase, which has a capacity of 2 quarts.

The pump is a positive displacement gear type, rated 30 g. p. m. at 250 p. s. i., at 2,600 r. p. m., and is equipped with chevron packing held in place by gland nuts which need be hand tightened only. Pump bearings and pilot gears are packed with grease and require service once annually. Connection of the pump to the engine is direct through a flexible coupling.

Standard accessories include:

- Adjustable carrying handles.
- 1 pressure gage, 0–500 p. s. i.
- 1 starter rope.
- 1 extra set spark plugs.
- 1 spark plug wrench.
- 1 packing gland wrench.
- 1 pair pliers, 6-inch combination.
- 1 screw driver, 4-inch.
- 1 set, magneto and breaker point adjusting tool and space gage.
- 1 crescent type wrench, 10-inch.
- 1 canvas tool kit.
- 1 can grease, 1-pound, suitable for packing gland and bearing.

Performance of portable pumper, U. S. F. S. R–5 Model 49, compared with specifications, revised March 23, 1948, as follows:

Specifications:	Test results
Maximum weight: 200 pounds	190 pounds
Maximum dimensions: 34 by 24 by 22 inches	29 by 22 by 21 inches
Vacuum when new: 20 inches Hg. minimum	22.5 inches Hg.
Vacuum after 100 hours; 15 inches Hg. minimum	16 inches Hg.
Normal output: 30 g. p. m. minimum at 250 p. s. i.	31.5 g. p. m.
Maximum output when new: not less than 25 g. p. m. at 310 p. s. i.	25.35 g. p. m.
Maximum output after 100 hours: not less than 23 g. p. m. at 300 p. s. i.	23.03 g. p. m.

Cost of the pumper complete with listed accessories, f. o. b. Arcadia, Calif., was approximately $585 as of April 1949.

This unit is more suited for the large tanker or slip-on installations, or for areas where higher pump capacity is essential to effective control. While the electric start feature is a decided advantage, it should be recognized that a 12-volt system is required, thereby adding approximately 115 pounds extra weight. If desired the pumper is available without electric start at $480, as of April 1949.

Specifications covering these pumper units as well as details regarding tests and performance are available at Arcadia Fire Control Equipment Development Center, 701 North Santa Anita, Arcadia, Calif.

Woods Burner's Waterloo.—The following filler, taken from a recent issue of Bois et Resineux, explains what must have been a very effective forest fire control program in Napoleonic France.

In 1808 Napoleon I wrote one of his prefects the following letter:

Monsieur le Prefet, It has come to my attention that numerous forest fires have broken out in the section I have entrusted to your administration.

You are hereby ordered to have anyone guilty of starting fires shot at the scene of the fire. Furthermore, if fires continue, I will make arrangements to have you replaced.

Napoleon.

—Reprinted from Naval Stores Review.

USE OF PORTABLE FIRE PUMPER DURING SEPTEMBER 1932

PAUL H. RUSSELL

Assistant Supervisor, Nantahala National Forest

[The following article, written by P. H. Russell 17 years ago, has been included in this issue because it may be of interest to fire control men concerned with the development and use of portable pumps.—Ed.]

During the latter part of August 1932 a small fire occurred in the Cedar Run section of Summerhill Township, Cambria County, Pa., and was thought to have been completely extinguished. On September 8, this fire broke out and burned over a large part of an old dried out swamp. The fire was brought under control during the evening of the first day. Beaver Run ran along the west side and Cedar Run ran diagonally through the burned area. It was decided that on the following morning a portable fire pumper, which was lying in storage, should be rigged up and used. A crew, composed of four reliable men, was organized to operate the pumper and arrangements made for the use of a truck to transport the equipment. On the morning of September 9, the pumper started working on the Cedar Run fire. After 3 days on the Cedar Run fire, the pump was moved wherever it could be used. From September 9 until September 23 it was used every day except one and saw service on five fires.

Actual running time on the five fires was as follows:

Fire:	*Running time (hours)*	*Area burned (acres)*
Cedar Run	91	60
Summerhill	12½	6
No. 6 Schoolhouse	10½	5
Summit Country Club	1	½
Ebensburg	13	40

Thus, during the 2-week period, the pump worked a total of 128 hours, consuming 134 gallons of gasoline and 52 quarts of oil, and throwing approximately 15,000 barrels of water.

On an average the pump consumed 1.048 gallons of gasoline and 0.406 quart of oil per hour. With the total cost of the crew and transportation at $399.77, the gas and oil at $69.44, and a depreciation of $2 per running hour, the average cost per running hour would be as follows:

	Cost per running hour (dollars)
Crew and transportation	3.12
Gas and oil	.54
Depreciation	2.00
Total	5.66

The extremely dry period of September, with the conditions such that it was very difficult to completely extinguish fires, provided an excellent opportunity to try out the pumper. Several interesting observations were made.

On each of the first several days the pump was used, there could be noticed a considerable increase in the efficiency of the operating crew. This was due to the increasing familiarity with working details of the pump and hose and the use of water to the best advantage.

It was also shown in convincing manner, especially on the Cedar Run fire, that the pumper will not serve as a substitute for a well-constructed line. There were six breakouts on the Cedar Run fire that burned more than one-tenth of an acre. Only two of these breakouts were controlled by the pump without putting in a good line. One breakout was controlled by use of the pump before the middle of September when the fire still burned very slowly. The other breakout was controlled by the pump after the middle of September when fires burned as fast as a spring fire, and then only because the pump happened to be placed in an advantageous position and hose already partly strung out so that the breakout was fought before it had reached a size of more than one-fourth of an acre. The conclusion is that, unless the pump is already advantageously placed and plenty of hose immediately available, it is almost impossible to stop a fast running fire with the pump alone. This is due to the fact that the pump and a long stretch of hose cannot be moved fast enough.

On the Paddy Meadow fire, all but two breakouts occurred after the edge of the fire in to a distance of 40 feet had been completely wetted down for hours at a time. In one instance, the pump forced water on a small breakout for more than 3 hours on three separate occasions and yet, a day later, the largest breakout of the fire started from this same area. On the basis of a cost of $5.66 per hour to run the pump, this would be the equivalent of about 16 man-hours. There is a question as to whether in many situations the pump will do more than its equivalent in manpower, but under ordinary conditions it is undoubtedly more efficient in mopping up and is fairly convenient.

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PROGRESS ON PROPOSED FOREST SERVICE STANDARD SLIP-ON TANKERS FOR ¾- AND 1-TON VEHICLES

ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER
Region 5, U. S. Forest Service

One of the Service-wide development projects assigned to the Arcadia Fire Control Equipment Development Center was the design and construction of a medium-weight slip-on tanker to fit pickup and express bodies of ¾- and 1-ton trucks, and which would meet the varying needs of all Forest Service regions.

In order to incorporate the most desirable features, suggestions and requirements were solicited from field men and many existing units were inspected in several regions. Information thus secured clearly indicated that the objective was the construction of a versatile unit, with the component parts so designed and mounted that alternate positions for pump, reel, and tool box and a reasonably wide selection of pumpers were possible. Furthermore, water capacities should be provided consistent with proper loading of either the ¾- or 1-ton vehicles and for either mountain or flatwoods operation.

The first unit designed and reported upon herein is for mountainous areas (fig. 1). A skid frame cradles the 125-gallon water tank and a watertight equipment compartment which can be used as a container for an additional 75 gallons of water when a 1-ton vehicle provides transportation.

The slip-on tanker is secured to the vehicle by means of four chains attached to the top of the frame. At the ends of the chains are hooks which engage eye bolts mounted in the bed of the vehicle.

On the top of the skid frame a rectangular base, supporting the reel and pumper, is attached by means of four bolts. This allows for reversing position of reel and pumper. And since, in plan view, the unit is square the user has a choice of eight different arrangements of reel, pumper, and tool box location when installing the unit in a vehicle.

The dry unit with pumper and reel, but without tools and equipment, weighs 623 pounds. The loaded unit, with tools and equipment as listed further in this article, weighs 1,910 pounds.

Water tank.—The water tank is 47 inches long, 30 inches wide, and 20 inches high, constructed of 14-gage black iron, and divided into four compartments by baffle plates. The entire top is removable to facilitate cleaning. The interior of the tank is treated with a sanitary rust preventive compound. Two sets of tank outlets are provided on the lid to allow for reversing positions of pumper and reel. These serve for fill spout, outlet for suction line from tank, tank vent, and relief valve discharge to the tank.

Equipment compartment.—Mounted alongside the water tank is a watertight box 47 inches long, 16¾ inches wide, and 21½ inches high, which serves as a tool box or as an auxiliary water tank (fig. 2).

For the purpose of safety, cutting tools are mounted on underside of the lid. Long-handled tools and suction hose may be mounted as desired, either on the unit or on the vehicle.

When a ¾- or 1-ton vehicle carrying the slip-on is operating on level highway, or at slow speeds on the fire, the tools and equipment can be removed from the equipment box, which can then be used for carrying an additional 75 gallons of water. Water is drawn from this compartment by means of the overboard suction hose. Revisions in the tank which will permit cheaper construction and eliminate the necessity for using the suction hose to draft from equipment box are planned.

Pump and reel frame.—The pump and reel frame is 50¾ inches long and 21 inches wide. Sufficient space is provided on the frame for mounting a hose reel 23 inches long and 21 inches in diameter. The space and installation facilities for the pumper permit the use of several different makes and models of portable pumpers now manufactured.

Pumper.—The pumper unit, which was installed on the pilot model, and illustrated in figure 1, has a rated capacity of 18 gallons per minute at a pressure of 250 pounds per square inch. It is of the positive displacement gear type and weighs 96 pounds. The engine is an air-cooled 4-stroke cycle gasoline type, rated at 6 horsepower at 2,700 revolutions per minute and is equipped for rope starting only.

Reel.—The high-pressure live hose reel will carry 250 feet of 1-inch cotton-jacketed rubber-lined, or ¾-inch high-pressure rubber-covered

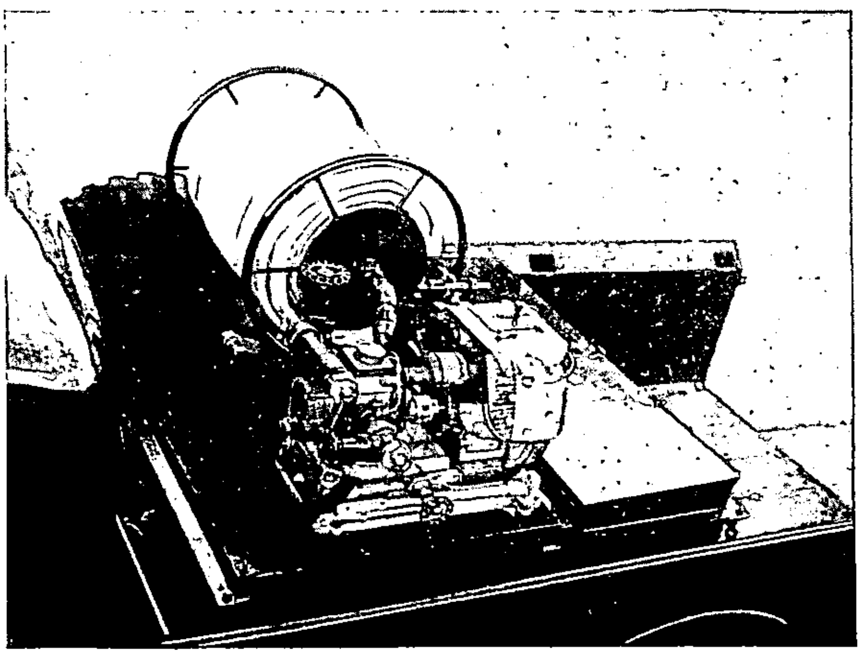


FIGURE 1.—Mountain type slip-on tanker for ¾- to 1-ton vehicles.

hose. The reel is equipped with a quick-throw friction drag brake and a geared crank for winding in the hose.

An alternate reel arrangement, consisting of either one smaller reel or two reels in the same space and equipped for small-diameter hose (7/16-inch or 1/2-inch), is being considered.

Equipment.—One typical list of equipment is as follows:

250 feet—1-inch CJRL hose on reel	2—shovels, No. 0
250 feet—1-inch CJRL hose	1—ax
200 feet—1½-inch CJRL hose	1—brush hook
20 feet—1-inch suction hose	1—Pulaski
1—5-quart gasoline tank (full)	1—McLeod tool

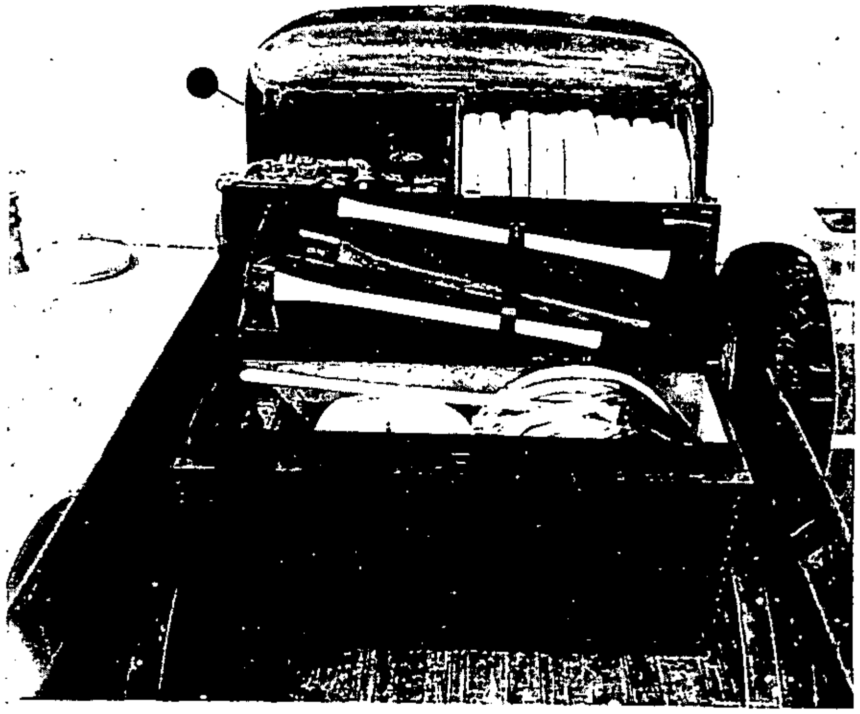


FIGURE 2.—Tools and hose arranged in box.

Since tools and equipment vary somewhat according to the user's choice, no specific brackets or tool racks are included on the proposed standard unit, but would be obtainable as accessories.

Radio installations.—When the slip-on tanker is to mounted in the vehicle with tool compartment to the rear and reel and pumper in line across the bed, suitable space is provided across the back of the cab and above the tank for a mobile radio installation having remote controls in the cab.

Cost.—Estimated cost of the slip-on tanker, equipped with Region 5 Specification Model 48 Pumper but without accessories, is approximately $800. Information received from one manufacturer would indicate an eventual cost of about $650, if produced in quantity.

Thirteen units have been constructed and a few are now in experimental use in the field. Reports and comments on the unit to date have been very favorable.

Future work.—Following the completion of the mountain and flatwoods models a detailed report with photographs fully illustrating the versatility of the units will be made available to Forest Service regions and to State, private, and other Federal forest protection agencies for review and comment. Such reasonable changes as are essential to meet the needs of the interested agencies will then be made and the final proposal submitted as standard items of equipment for the Forest Service. If the resulting unit is satisfactory for adoption as standard by other agencies a reduction in the cost per unit can be expected.

Spiral Rotor Trencher—Preliminary Performance Report.—The January 1949 issue of Fire Control Notes describes the spiral rotor trencher designed and constructed in Region 6. Two of these units are being tested for performance on the Sierra and Trinity National Forests of Region 5, under procedures outlined by the Arcadia Fire Control Equipment Development Center. The purpose of the test is to determine the varying types of terrain, cover, and soils in which the machine can be operated as well as to bring out any weak spots in the mechanical construction of the equipment. The following is a brief summary of observed results to date:

Timber type.—The rotor trencher produced an excellent fire line in all types of duff encountered, whether composed of needles from pine or fir, or leaves from hardwood species. A fire line 18 inches wide was cut to mineral soil. A 6-inch berm on each side, composed of duff and dirt, added to the effective width. The trencher is able to push limbs, poles, and rotten logs aside so that very little advance clearing is necessary. Single-pass fire line is built at the rate of approximately 1 mile per hour.

Open-grass type.—Grass type, as a rule, proved the most difficult, because of the hard baked soil underneath. In one area a fire line 18 inches wide was constructed in which the grass was stripped off and very little dirt was moved. In contrast to this, where the soil was less firm, a 20-inch line in mineral soil was built, plus an 8-inch berm on each side, composed of grass covered with dirt, giving a 36-inch effective fire line.

Operating up a 20-percent slope, fire line was constructed at a rate of 0.92 mile per hour. Down the same slope, line was built at the rate of 1.24 miles per hour.

Bear clover.—The rotor trencher had no difficulty building a 19-inch line in bear clover, at a rate of three-quarters of a mile per hour. It could climb and build fire line up to a 50-percent grade in this type cover.

Mixed chaparral.—The rotor trencher was not designed to cut brush, but it was found a useful tool in this type, to build fire line around and underneath the brush by "worming" its way around obstacles. With a minimum of clearing in advance a good job can be done on "cold-trailing" in brush types.

Chamise type.—The rotor trencher is capable of building fire line in this type, since the stems are brittle and root systems are not too substantial. However, going is rough on both the machine and the operator.

Terrain.—Rocks up to 5 inches in diameter are readily handled by the trencher if they are in loose soil. Rocks imbedded in hard soil cannot be moved and should be avoided when possible. However, the machine is able to slide around the obstacles without too much abuse to the machine.

Fire line was built on side slopes up to 45 percent without difficulty when the surface was smooth.

The spiral rotor trencher shows promise of general adaptability to line construction in most fuel types. As in all new designs mechanical failures have been encountered. Difficulties in carburation on side slope and slipping of belts in the steering mechanism are problems that will require revised design. The principle of the spiral rotor for line construction, however, has definitely been proved to have merit.

Conclusion of the tests is scheduled for approximately January 1, after which a complete report covering rates of construction, grades, and fuel types to which the machine is adaptable will be made.—ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER, *Region 5, U. S. Forest Service.*

SLIP-ON CONVOY LUBER AND FUEL UNIT

Arcadia Fire Control Equipment Development Center

Region 5, U. S. Forest Service

One of the 1948 Service-wide projects assigned the Arcadia Development Center was a slip-on convoy luber and fuel unit to service fire camp equipment and trucks on fire lines away from roads. Such a unit has been built and tested, and is reported briefly in the following:

The unit is designed to fit a ½- or ¾-ton pickup, but can be used in 4 x 4's or 1½- to 2-ton stakesides, as well as in the multi-purpose tractor-drawn trailer, described in the April and July 1948 issue of Fire Control Notes, Vol. 9, page 31.

The luber consists of a gas engine driven compressor and air storage tank, two pressure lubrication pots, and a tool box mounted on a skid frame (fig. 1).

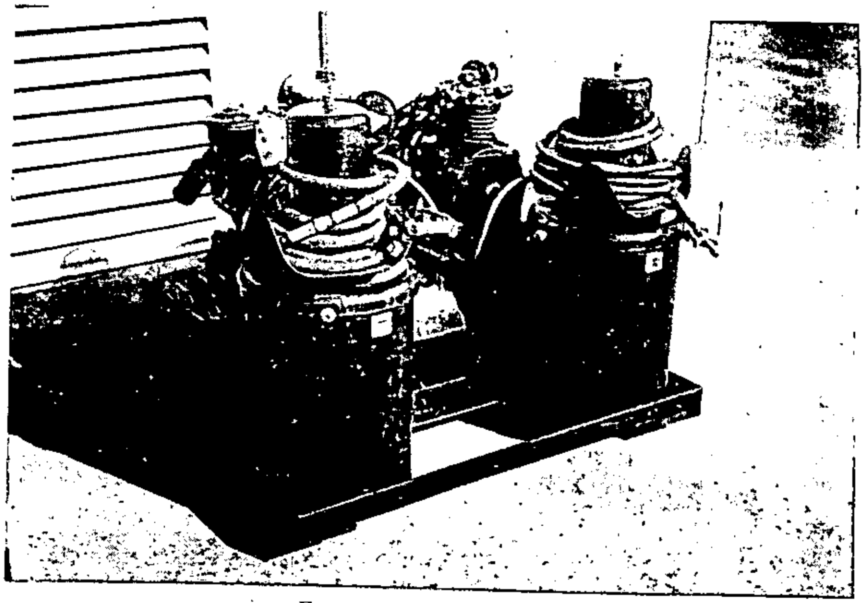


Figure 1.—Slip-on luber.

The over-all dimensions are 3 feet 9 inches long, 2 feet 5 inches wide, and 3 feet 1 inch high. The two-stage compressor is belt-driven by a 4-cycle gas engine. The air tank is 12 inches in diameter by 36 feet long, built for a maximum operating pressure of 175 pounds. A pressure regulator and 24 feet of ¼-inch high-pressure air hose are provided.

The two lubrication pots have 100 pounds grease capacity each. One is provided for E. P. 90 gear lube and the other All-Purpose chassis lube. Each pot has 20 feet of high-pressure lube hose and a grease gun.

The tool box is 6 inches wide, 14 inches high and 14 inches long, and holds the grease fittings, air fittings, and the necessary hand wrenches and tools.

Estimated cost of this unit is $575, f. o. b., Arcadia. Weight is 625 pounds.

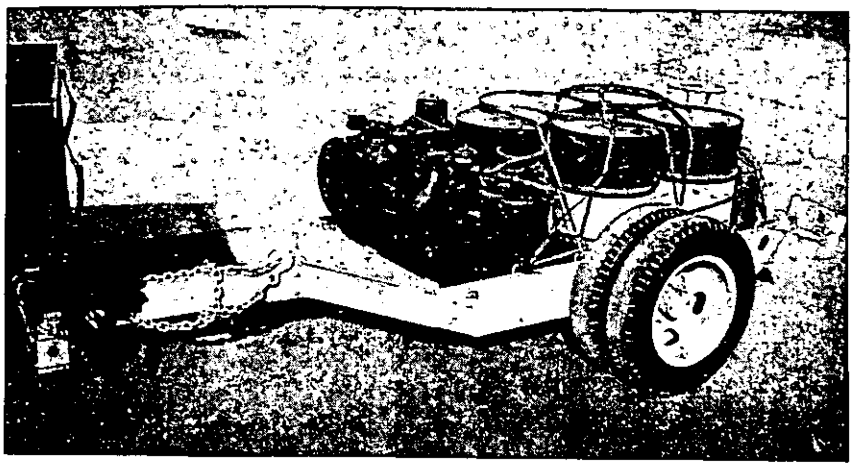


FIGURE 2.—Luber and fuel supply in utility trailer.

When this slip-on luber is used in the tractor-drawn trailer (fig. 2), four 55-gallon drums of Diesel fuel, one 30-gallon drum of water, one 15-gallon drum of motor oil, and two 5-gallon G. I. cans (one for cleaning solvent, the other for gasoline) can be carried.

The supplies noted are in about the right proportions, and have been used to service five D–7 or D–8 tractors for one 12-hour shift, or one D–7 or D–8 tractor for five 12-hour shifts.

The tool box on the trailer tongue will hold one oil measure can, one 5-ton jack, one taillight bracket, one clearance light bracket, one trailer hitch, 50 feet of ¾-inch manila tie rope, one barrel pump plus 10 feet of fuel hose, and some wiping rags.

The luber, plus the above load in the trailer, was designed to be pulled behind the tractor on its first trip into the working area. This saves the time of walking the tractor, or tractors, out to the road for servicing and back into the working area.

Plans and detailed construction drawings are available and may be obtained for all of the above described equipment from the Arcadia Equipment Development Center, U. S. Forest Service, 701 North Santa Anita Avenue, Arcadia, Calif.

[Since design of the luber there have been many versions of the convoy luber made available commercially. The Development Center will be glad to forward list of manufacturers and descriptive literature to any who may be interested.]

NEW PLASTIC TOWER PROTRACTOR

NEIL LEMAY

Chief Ranger, Forest Protection Division, Wisconsin Conservation Department

The Wisconsin Conservation Department is now starting its second year with the new plastic tower protractors, and to date the protractors have held their shape and accuracy and have stood up well under usage.

Prior to 1948 we used, with a few exceptions, paper protractors and maps mounted on Prestwood in our towers. We were constantly confronted with distortion due to mounting and with considerable replacement of the units. We tried to protect the mounted map and the protractor with glass covers, varnishing, etc., but still did not attain the desired results. As a consequence we searched for some other material for our protractor and for another method of providing the towerman a map that would not have to be replaced so frequently.

Investigation led to the selection of a plastic protractor 20 inches in diameter made of General Electric Textolite No. 2097 (fig. 1). The protractor was drawn to scale at our drafting office and was graduated in degrees and half-degrees with numbers every 10 degrees, running clockwise from zero to 360 degrees. From this the fabricating company prepared a plate and printed it on the face sheet of plastic, black on white. (This can be reversed if so desired.) This face sheet was then incorporated as a part of a laminated plastic structure to form a plastic sheet about 0.07 inch thick that is stable and practically indestructible. This was done at a cost of less than $2 per protractor in lots of 100. A 3/16-inch hole was drilled in the center of each protractor for fabrication purposes.

It was recommended by the fabricating company that these protractors be mounted on waterproof 7/8-inch plywood, using Cascamite or Weldwood with at least 50 pounds per square inch pressure, for the protractor unsupported has a tendency to warp though it does not change dimension. It was found that this mounting was easily accomplished with our shop hydraulic press, and as a matter of fact we used about double the required pressure and bonded as many as 30 protractors and bases at one time. We have had no failure in the cementing up to the present time, and it appears likely that none will occur.

To eliminate wear on the face of the protractor, plain black 10-inch diameter disks of Textolite (grade 10700 with black filler) were secured. They were placed on the protractor and served as a base for the alidade to ride on, keeping it just clear of the numbered edge of the protractor. The disks can be successfully cemented to the face of the protractor with Cascamite if desired.

The protractors were then carefully oriented in the towers by using azimuths from triangulation control data and securely fastened to the tower cabinet.

This arrangement prevented us from mounting a map with the protractor as we had done before, and so we are trying out the following map scheme. In place of the maps of ½-inch-per-mile scale that we formerly used, we have substituted our quadrangle maps, scale 8/10 inch per mile, similar to the ones used by our dispatchers. The new tower maps have 6-inch protractors overprinted in red ink and are mounted on quarter board. They are composed to give about 15 miles coverage in all directions from the tower. Eyelets are inserted on each tower position on the map, as in dispatching maps, and either strings and weights or celluloid arms are used to cross up the fires. The maps are framed, varnished, and mounted so as to hinge up to the tower ceiling or against the side so that the map is protected except when actually being used. It is our hope that this system will give more service than our previous one and will also give more accurate information to the towerman.

For further information, such as source of supply of plastic disk, write to Chief Ranger, Forest Protection Division, Wisconsin Conservation Department, Tomahawk, Wis.

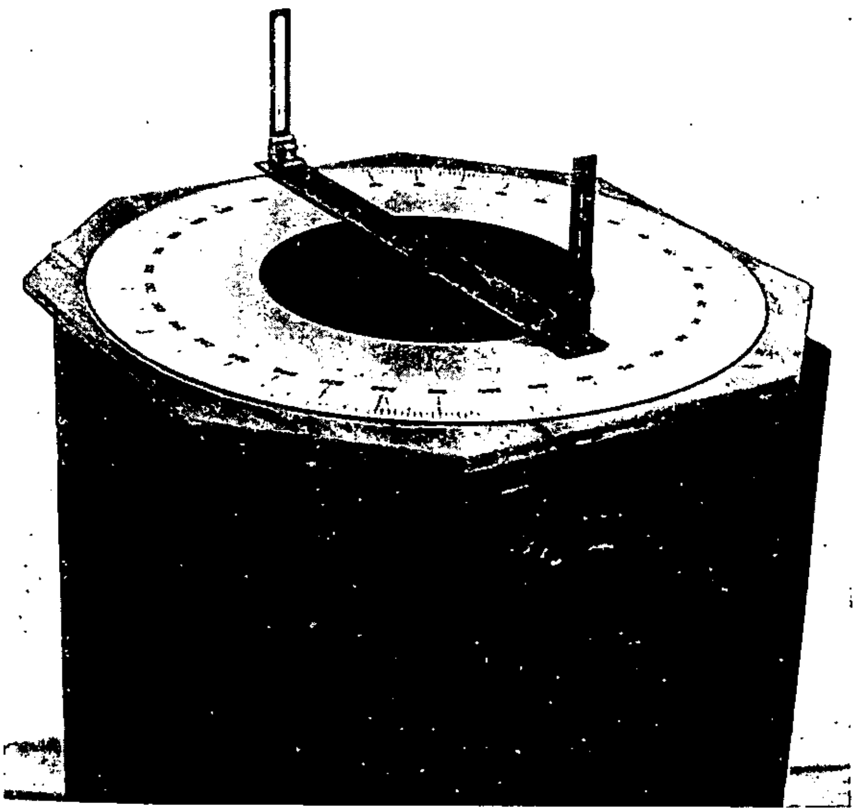


FIGURE 1.—Plastic protractor oriented and securely fastened to tower cabinet, showing riding position of alidade on Textolite disk. Protractor is 20 inches in diameter and is mounted on waterproof ⅞-inch plywood.

ARKANSAS FIRE FINDER

G. M. Conzet

Forester, Region 8, U. S. Forest Service

The Arkansas Division of Forestry and Parks is now equipping all of its towers with a new azimuth circle and alidade that are an improvement over the instruments currently used by many States. The project for developing this equipment was initiated and guided by Fire Control Chief R. M. Henry with the cooperation of Max Levine, instrument maker, and Carl Martin Manufacturing Co. of Little Rock, Ark. The equipment has been designed and built for simplicity and sturdiness as well as for ease and accuracy in operation.

The azimuth circle is 21 inches in diameter with 1-degree graduations and ½-inch figures stamped on aluminum plate $\frac{3}{16}$ inch in thickness and 24 inches in diameter. This makes a permanent rigid base and circle. In order to reduce glare to a minimum, the surface of this plate is coated with black wrinkled enamel sprayed on and baked. The stamped-in figures and degree marks are filled with phosphorescent paint to make them stand out better for both day and night reading.

The mounting of the aluminum plate and azimuth circle is by way of hinge-type guides attached to the under side. Opposite the guides are two leveling screws. The guides slide on a straight ¾-inch steel rod attached to a baseboard by brackets and bolts. The bolt holes for attaching the guides are slotted to provide for minor adjustments (as much as 5 degrees) when orientating the circle. There are 10 inches of lateral movement on the steel bar, which is sufficient to clear most tower cab obstructions in sighting. Opposite the slide bar and parallel to it is a flat iron bar bolted to the baseboard. This provides a true surface for the leveling screws. A center hub or pivot base with dowel, lock washer, and tension spring is attached to the center of the azimuth circle plate by four countersunk screws.

The main bar and sighting vanes of the alidade are of special high-strength, heat-treated aluminum riveted together permanently and finished with nonreflecting black paint.

All friction surfaces are of brass to prevent galling of those parts. The sighting vanes are 6 inches high and 18 inches apart. The bar and vanes are 1½ inches wide. The front vane has a vertical hair while the rear or near vane is slotted. This rear vane has a round opening close to the top and one near the bottom for coarser sighting or for use when light is poor. The rear end of the bar protrudes 2½ inches beyond the sighting vane, thus providing room for a circular opening 1¼ inches in diamter directly over the azimuth circle figures and through which the reading is made. To provide for accurate reading a black nylon index has been placed in this opening in direct line with the sighting parts of the vanes.

The azimuth plate is mounted with "O" azimuth to the south so that bearings may be read direct from the rear of the alidade.

Mr. Henry advises that manufacturers are now prepared to go into mass production. Prices from $15 to $37.50, depending on the number ordered, have been quoted. Inquiries for further information, including names of suppliers, should be addressed to R. M. Henry, Fire Control Chief, Arkansas Division of Forestry and Parks, Little Rock, Ark.

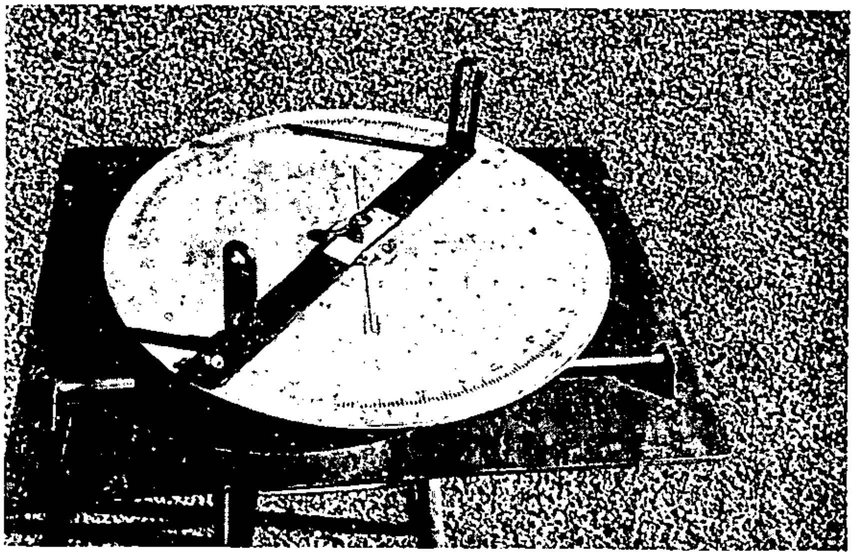


FIGURE 1.—Over-all view of the Arkansas fire finder before plate has been enameled and the figures and degree marks filled with phosphorescent paint.

IMPACT OF DESTRUCTIVE FOREST FIRES ON THE TIMBER RESOURCE OF A MANAGEMENT UNIT

C. A. GUSTAFSON

Chief, Division of Fire Control, U. S. Forest Service

During 1945–47 a study of a management unit covering 1,689,400 acres of a major watershed was carried on to determine the total land area capable of supporting a stand of timber. A fire study was carried on simultaneously to determine the impact of destructive fires on the current timber producing capacity of the land, and to define that impact in economic terms.

An aerial photographic survey of the management unit provided the base for interpretation and determination of land capabilities. Sufficient field work was carried on to make sure that aerial photographs correctly interpreted can be used to classify land capabilities, particularly if those making the study are intimately familiar with the area. Other sources of material were fire reports, cut-over reports, cruise data, and management plans. Contacts with local people and others provided valuable information concerning fires that burned prior to 1905, at which time organized fire protection was begun, and immediately following 1905 when statistical fire data were not recorded in a completely satisfactory manner.

The land capability study of the management unit indicated that prior to the coming of the white man approximately 1,168,300 acres were covered with a stand of timber averaging about 20,000 board feet per acre (fig. 1). The total area of the unit was classified as follows:

Land capability:	*Acres*
Timber producing	1,168,300
Not suited to producing timber:	
Sagebrush and grass	39,000
Meadow	104,100
Lakes	3,000
Nonproducing [1]	375,000
Total	1,689,400

[1] Includes such areas as brush fields not capable of growing timber, land not suitable for agriculture nor supporting a stand of grass, rock outcrops, and barren land.

The fire study revealed that very few destructive fires occurred in the unit prior to the arrival of the white man. It is evident, however, that numerous lightning fires did occur although very few resulted in complete destruction of the timber stand. The total area on which the timber was destroyed by fire prior to 1905 was determined as slightly less than 50,000 acres.

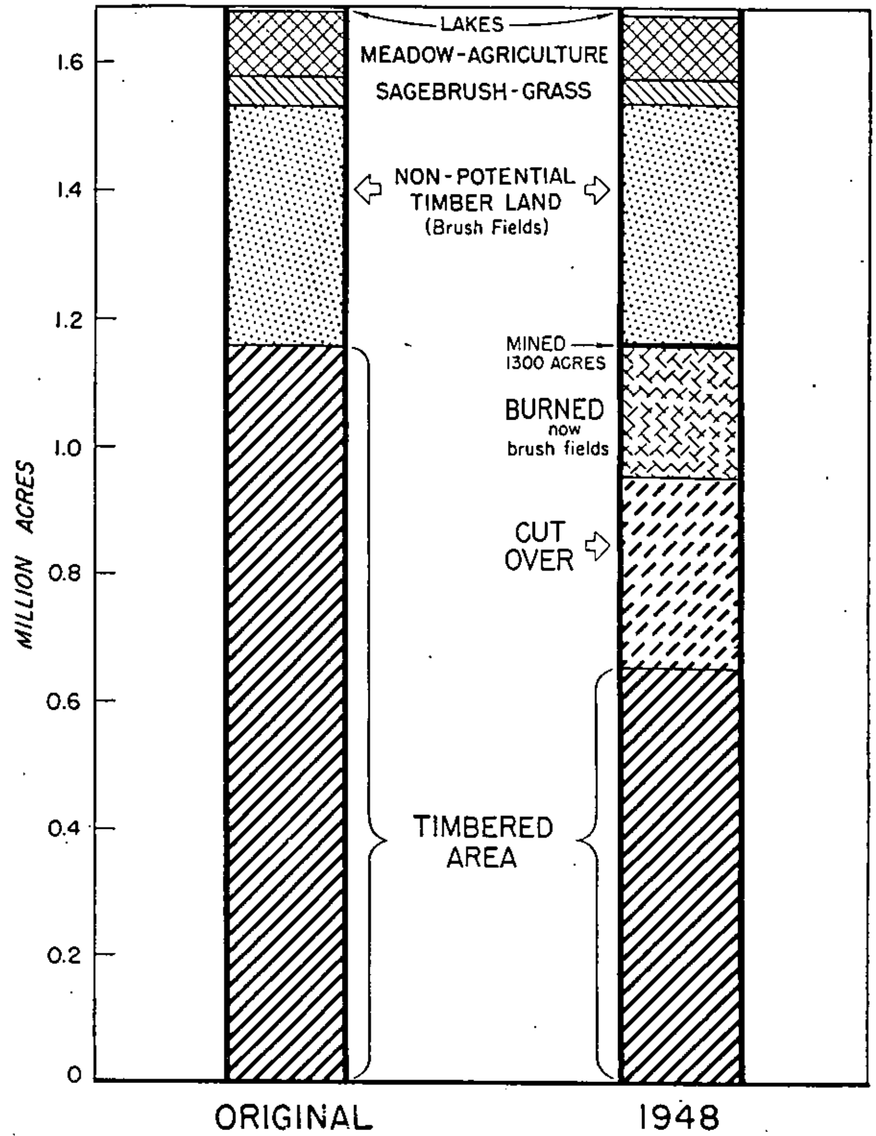


FIGURE 1.—Original timber resource situation as compared with that of 1948.

The aerial photographs were studied and the boundaries of destructive timberland fires were delineated on the map. These were confined to fires that crowned out, thus resulting in total kill of the timber stands.

Fire reports were studied to determine the year the original fire scars were made. After all available reports were considered, there remained a number of fire scars to which a date of origin could not be attached. Discussions with local people and others known to have worked in the area provided some helpful information. In this way

the year and area of the destructive forest fires occurring within the unit after 1905 were determined (table 1). All fires previous to 1905 were lumped together.

The date assigned each of the destructive fires that resulted in a nonreproducing brush field was the date of the fire resulting in total destruction of the timber stand. There may have been fires previous to this date that burned over the area, but that did not get into the crowns and completely kill the timber. Also, there may have been some reburns of brush fields, but these were not cataloged since they did not result in the destruction of the original stand of timber.

Table 1 shows that 4.16 percent of the timbered area of the management unit was destroyed by fire previous to 1905. It also shows that during the 44-year period 1905–48 the fire-control organization failed to reach the area burned objective (one-tenth of 1 percent), except during 1940–44 when the average annual burn was kept to 0.092 percent. The percent of timberland burned was obtained by dividing the area burned during the period by the total area of timberland remaining at the beginning of the period. As the total timbered area decreased, the allowable burn objective in acres became smaller. For example, in 1905 it was 1,117 acres, while in 1949 it would be 958 acres. This type of calculation was used in determining the effectiveness of fire-control measures in the protection of the unit. Figure 2 shows the relative success or failure in protection, failure being considerable in the period 1905–34, success being approached or reached during the period 1935–44. It also shows that since 1944 the fire organization is again operating on the failure side of the burned area objective line.

Table 1 and figure 2 show rather conclusively that successful forest management is not possible for this unit, with the degree of protection that has been provided.

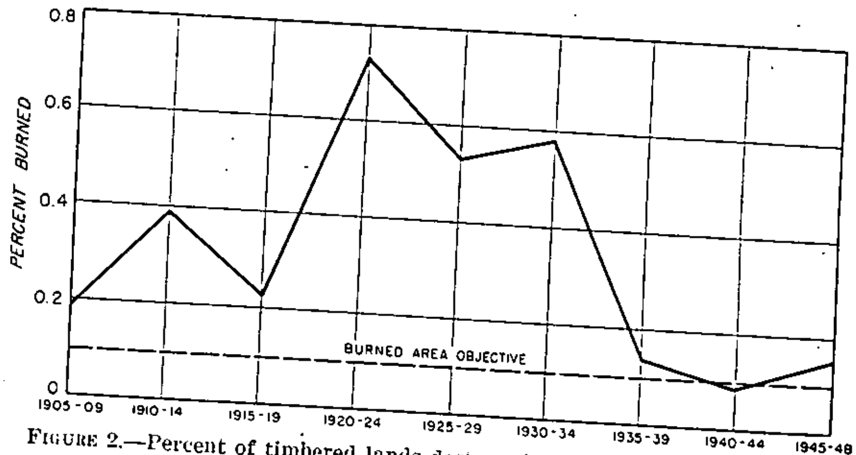


FIGURE 2.—Percent of timbered lands destroyed by fire, by periods, 1905–48.

A review of the condition of the management unit as of 1948 (fig. 1) showed that out of the original 1,168,300 acres of timbered lands, fire had brought about the formation of 209,000 acres of nontimber producing brush fields. The 209,000 acres on which the timber was destroyed is not a true measure of the total timberland burned over,

TABLE 1.—*Area of timber destroyed and percent of timbered area burned by destructive fires, by periods*

Period	Timber stands destroyed	Area remaining in timber at end of period	Timbered area burned	
			By period	Annual average
	Acres	*Acres*	*Percent*	*Percent*
Prior to 1905	49,000	1,117,800	4.16	
1905–09	10,600	1,107,200	.94	0.188
1910–14	21,500	1,085,700	1.94	.388
1915–19	12,400	1,073,300	1.14	.228
1920–24	39,300	1,034,000	3.66	.732
1925–29	27,700	1,006,300	2.68	.536
1930–34	29,200	977,100	2.90	.580
1935–39	7,100	970,000	.71	.142
1940–44	4,500	965,500	.46	.092
1945–48	7,500	958,000	.78	.195

because many of the large fires did not go into the crowns. The figure represents the area of crown fires that resulted in a total destruction of the timber stands. Loss of increment due to ground fires must have been quite high, but there was no way to determine this loss from the data readily available. Mining, primarily in the form of hydraulic diggings, took another 1,300 acres of timberland out of production. Hence by the end of 1948 there remained 958,000 acres of land currently producing a timber crop. The situation at the end of 1948 was as follows (fig. 1):

	Acres
Timbered area (including virgin and cut-over areas)	958,000
Potential timberlands (timber totally destroyed by fire, now brush fields)	209,000
Nonpotential timberlands:	
Mining diggings	1,300
Sage brush and grass areas	39,000
Meadow and agricultural land	98,000
Lakes	9,100
Brush fields, rock areas, etc	375,000
Total	1,689,400

A review was made of the 14 most destructive fires occurring in the 44-year period 1905–48. These 14 fires destroyed about 85,000 acres of timber, or approximately 53 percent of the total area destroyed since 1905. They were all extra-period fires, thereby emphasizing the need for early aggressive attack on all fires starting during periods of high fire danger and for employing the best skill possible in their control. The years in which the most destructive fires occurred were 1905, 1910, 1918, 1924, 1926, 1931, and 1934, with 1924 probably the worst, followed by 1926 and 1934.

Destructive fires on this management unit have resulted in the loss of 4 billion board feet of timber. This includes a calculated loss of increment, approximately 140 board feet per acre per year, due to taking the timberland out of production. It does not include the millions of board feet salvaged during the period. Slightly more than 3 billion feet of this loss occurred after the unit was placed under protection in 1905. Figure 3 shows the timber volume losses due to destructive fires.

The volume logged since 1905 totals 5.2 billion board feet (fig. 3), including the volume of burned timber that was salvaged. About

299,000 acres of the original timbered area of the unit has been cut over (fig. 1).

The original volume of timber on the unit is estimated at 22.4 billion board feet. Volume lost as a result of destructive fires is 4 billion board feet and the volume removed through logging totals 5.2 billion board feet. The estimated volume remaining on the unit at the end of 1948 is 13.2 billion board feet of which about 10 billion board feet is classed as commercial.

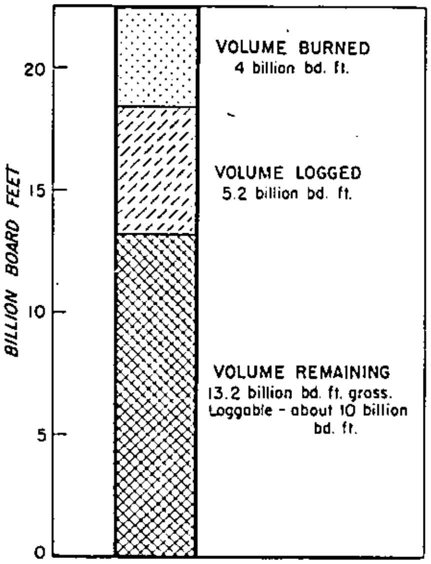


FIGURE 3.—Reduction in total original volume of timber due to fire and logging.

The figures on volume reduction reveal that 43 percent has been due to fires. In other words, the loss of timber by destructive fires has almost kept pace with the volume taken out through logging. Another way of emphasizing the severity of fires is to state that the potential pay roll lost because of fires is almost equal to the total woods and mill pay roll since 1905.

In order to determine the economic value of the total timber loss due to destructive fires, the average price per thousand board feet for timber sold by the management unit in 1948 was used. This figure, $13.16, applied to the volume destroyed, reveals that the present value of timber lost due to previous destructive fires would amount to the staggering sum of $52,640,000.

Most of the destructive timber fires in this area result in the creation of dense brush fields where it is almost impossible for regeneration of trees to take place. The destructive fires usually take the land out of timber production for a great many years, in some cases for more than 100 to 200 years. For that reason, the annual increment loss due to these fires may be directly chargeable to failures in fire protection. This loss is estimated at 29 million board feet annually. The current average stumpage rate of $13.16 per thousand board feet applied to this volume indicates that the owners of the management unit are losing about $381,640 each year because of past failures in fire protection.

This dollar value, which is charged as an annual increment loss, is 2½ times the $150,000 now being spent annually by the owners to protect the unit. The protection price being met by the owners, however, is not the $150,000 actually being spent, but more than $500,000, which includes the monetary value of the annual increment loss due to past failures in protection. Looking at it another way, if successful protection had been accomplished through the years, the value of the annual increment now lost would more than pay the present annual protection bill.

The total loss in loggable timber, calculated at a value of $52,640,000, cannot be overlooked. If the owners had spent such a sum on fire protection and the protection had been successful, they would have at least broken even. It appears defensible, therefore, to say that more than $1,000,000 could have been spent annually for protection on the area. It is certain that this amount is many times the amount that would be needed to provide the degree of fire protection required to assure successful management of the timber resource.

It can be concluded that the failure in protecting this management unit from destructive forest fires has resulted in a real monetary loss to the owners. If they had annually invested a small amount of additional funds in protection, they would have approximately 160,000 acres of timber producing lands that they do not now have. In their present condition these lands will not produce any real timber values for more than a hundred years, unless artificial revegetation (somewhat doubtful in such brush fields) can be accomplished. In addition, the loss of the vast amount of raw material has meant a potential payroll loss of more than $100,000,000, a matter for real concern.

Intangible losses, never measurable, would undoubtedly raise the total loss chargeable to destructive forest fires much higher than that calculated here, probably to somewhere in the neighborhood of $200,000,000.

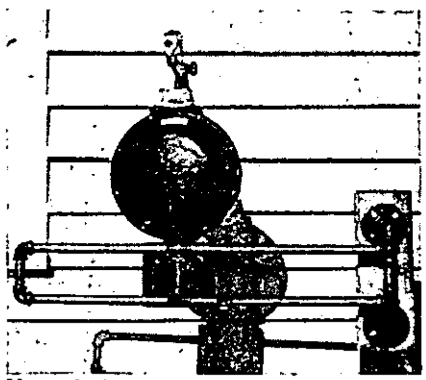
An analysis of losses due to destructive fires in relation to the amounts spent for fire protection might well be made for other timber management areas throughout the Nation. These analyses could provide forceable arguments for more adequate fire protection.

Navy Deck Alidade as a Forest Fire Finder.—The Connecticut Park and Forest Commission has installed in some of its towers a new forest fire finder, which may be of interest to others if the instrument becomes available in quantity at a reasonable price. The Commission purchased 20 of these instruments (Model O, Mark V) from the University of Connecticut's education department for 50 cents each. They were surplus property presumably acquired for training purposes.

This instrument, used by the United States Navy, is called surface lookout alidade or Navy deck alidade. It is a simple device with an azimuth circle that can be read easily and rapidly.

The high-powered finder was replaced by a ½-inch brass sighting tube about a foot long, with cross hair in it. Binoculars can be fastened on the sighting device if desired.

The State has not tested this instrument thoroughly, but several towers will be equipped with them for the 1950 spring fire season. Three have already been installed. One advantage of this finder over the ordinary alidade is it allows more room for the observer, and any visitors, in a 7- by 7-foot cab. It is also possible its use may increase accuracy. A disadvantage may be that it cannot to moved to avoid sighting into the four corner posts of the cab.—Ed Ritter, *Forester, Region 7, U. S. Forest Service.*



Navy deck alidade, with brass sighting tube. Azimuth is read at white strip.

STREAM FLOW AS A MEANS OF FORECASTING PERIODS OF EXTREME BURNING CONDITIONS

Mason B. Bruce

Forester, U. S. Forest Service, Washington, D. C.[1]

The White Mountain National Forest, like most of the New England State fire-fighting services, was caught napping during the fall of 1947. Standard fire-danger meters indicated the usual fall build-up of burning conditions which takes place as soon as fall frosts clear the trees of leaves. Although it was realized that general conditions were much drier than usual, no one on the forest foresaw the likelihood of such a catastrophic fire as the Fryeburg-Brownfield fire which made its major run just a few miles from the national forest boundary.

In an attempt to profit by experience, forest personnel spent considerable effort trying to find out how the extreme burning conditions might have been foreseen in time to alert local fire-fighting organizations and establish commensurate prevention and suppression safeguards. Graphs showing day-by-day fire danger as measured by 5–B and 5–W forest-fire-danger meters failed to give any indication of a build-up during the summer months of 1947. Charts showing occurrence of precipitation by days or periods likewise failed to show a trend sufficiently different from ordinary to be a basis for alarm. None of the accepted indicators seemed to give cause for apprehension.[2]

It was recalled that during the summer of 1947 local farmers complained that wells which had produced abundantly for long periods had gone dry during August and September, and the peak water shortage had occurred just about the time the huge fires reached their climax in October. Perhaps there might be a relationship between the sustained occurrence of unusually low ground-water levels and extreme burning conditions.

Unfortunately, the U. S. Geological Survey maintained no ground-water measuring stations in the vicinity of the National Forest. The nearest thing to an indicator of ground-water fluctuations seemed to be departures from normal in stream flow, there being a rather close

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[1] Formerly Assistant Supervisor, White Mountain National Forest.

[2] Forest Fire Danger Meters 5–B and 5–W were developed at the Southeastern Forest Experiment Station. Personnel at the station have believed for some time that the meters probably do not indicate as high danger as exists during prolonged periods of dry weather. They have consequently been doing some work with the idea of incorporating a drought factor. Progress to date has not been sufficient to know the value of its inclusion.

Use of the 5–W 100 meter was not begun in Region 7 until the fall of 1947. Consequently, White Mountain National Forest's experience with it in the month of October of that year was extremely limited. Since that time burning indexes for each day in October for the years 1943 to 1947, inclusive, were summed for New Hampshire. By October 21 the cumulated burning index for 1947 was 313 as against 139 in 1945, the next highest year. This would indicate a sharp build-up for that month in 1947.

Under similar conditions of drought, intermittent rains of small amounts should perhaps be ignored and the wind velocity carefully watched. Wind velocity is by far the major factor in fire danger, and an increase during a drought period is indicative of extreme danger.

relationship between stream flow and the supply of available ground water. The Geological Survey advised that it could furnish monthly discharge data for the year 1947 as well as monthly normals for one of the important streams leaving the forest. Current data for the same stream could be made available on the second day of each month for the preceding month.

Using the data provided, plus and minus departures in stream flow from monthly normals were plotted to a convenient scale. It was found that during 1947 a gradually increasing deficiency in stream flow became apparent in early July, reaching a peak in late October. The minor storms which occurred during late summer had little effect on the trend which showed strikingly on the graph. Here was a measurable trend that originated several months before the extreme burning period. It seemed that the method might furnish a practical, if empirical, means of forecasting conditions that lead to explosive forest-fire situations.

Further checking was needed to determine if similar sustained stream-flow deficiency trends may have occurred at other times in the past and, if so, whether these outstanding deficiencies were accompanied by bad forest-fire situations. Stream-flow data for the preceding 10 years were obtained from the U. S. Geological Survey, and departures from normal flows plotted in the same manner. During the decade prior to 1947 there occurred only one period, the spring of 1941, when stream-flow deficiencies comparable to late summer and fall of 1947 occurred. It was during this same spring of 1941 that the disastrous Stoddard-Marlow fire of some 25,000 acres occurred in west-central New Hampshire. Burning conditions were known to be extreme at that time and control was obtained with a change in weather. The other less extreme but relatively severe fire periods which had occurred in New Hampshire during the years studied tied in closely with measurable but less striking trends in stream-flow deficiency.

This coordination of events tended to confirm the original findings. The graph in a somewhat similar form has been kept current since 1947 as a means of forecasting the possibility of unusually extreme forest-fire situations. In no way does it replace the standard fire-danger meter for current fire-weather conditions.

WET WATER FOR PRETREATING LITTER FUELS

Wallace L. Fons and Robert S. McBride

California Forest and Range Experiment Station.

Forest fire fighters often use water to wet the unburned material bordering the fire line or to sprinkle the area adjacent to a backfire line as a safety measure to reduce spot fires and flaring across the line. The question has been raised as to how the application of wet water would influence the length of time this precautionary measure is effective.

To answer this question an experiment was conducted at Pilgrim Creek on the Shasta National Forest. Two types of forest fuels were studied: ponderosa and lodgepole pine needles, and ponderosa pine twigs ¼-inch in diameter and 4 inches long, with bark intact. The material (four samples of each) was loosely packed in wire screen baskets, 1 foot square and 2 inches deep. The samples were weighed and set out at 8:30 a. m. on a bed of pine needles fully exposed to sun and wind. At noon they were again weighed, and two samples of each fuel type were treated with water and two of each with wet water. The liquids were applied in the form of a fine spray until the samples were saturated.

After the wetting treatment, the samples were weighed periodically throughout the afternoon to determine the moisture losses by evaporation. To represent conditions of a typical fire day, a hot dry day was purposely selected for the study. Average temperature during the afternoon was 90° F., average humidity 17 percent, and wind velocity 4 miles per hour.

For ponderosa and lodgepole needles the evaporation loss during the first 20 minutes was greater with wet water than with plain water. After 20 minutes, however, there was a reversal and the greatest loss occurred from needles treated with plain water. This occurs because at first the wet water spreads over a greater area on the needles and thus exposes a large surface to evaporation. Conversely, the plain water does not spread readily but remains in droplet form, so that a smaller total area is exposed to evaporation. After a short period, however, the excess wet water evaporates; the remainder, which penetrates into the needles, is held tenaciously, reducing the rate of evaporation. Plain water does not readily penetrate the needles but remains on the surface and is evaporated.

For the twigs, though, this 20-minute reversal is not apparent. Twigs treated with wet water retained the most moisture in the first weighing. It is probable that both plain and wet water penetrate the porous bark of the twigs and evaporation is not solely a surface phenomenon. The wet water penetrates deeper and becomes more inaccessible to evaporation.

How may this information be applied to problems in the field? What does it mean to a man setting a backfire? Sixty minutes after spraying with wet water ponderosa pine needles had a 17.5 percent moisture content; those moistened with water alone had 12.5 percent. Let us assume a hypothetical case with wind of 10 m. p. h., slope of 30 percent, and temperature of 81°–90° F. Under these conditions the Region 5 fire danger indexes for moisture contents of 17.5 and 12.5 percent are 25 and 16. Therefore, we can say that the application of wet water instead of plain water, after 60 minutes, gives an advantage of 1½ in reducing the spread of fire.

Another way to look at the situation is this: We might suppose that a fire boss wants to backfire an area. He wets the adjacent material. However, he does not burn it immediately because of some unforeseen problem. How long will the wetting be effective, supposing that 12.5 percent is the critical moisture content? Water allows him 60 minutes to do the burning; with wet water he has 95 minutes before the moisture content reaches 12.5 percent. The use of wet water would give him an advantage of half an hour.

Aircraft Use, 1949.—Aircraft during 1949, in connection with fire operations by the U. S. Forest Service, made 7,957 flights for a total of 10,548 hours of flying. They transported 8,770 men and 1,318,000 pounds of cargo.

Tractor Dozer Use, 1949.—During 1949 tractor dozers were used on 287 fires fought by the U. S. Forest Service. Work accomplished involved construction of 22,339 chains of held fire line, 10,942 chains of safety and lost line, and 14,363 chains of "ways" prepared for the ingress and egress of transportation equipment, a total of 47,644 chains, or 895 miles, of fire line and "ways."

Tanker Use, 1949.—The U. S. Forest Service reports that out of a total of approximately 11,000 fires occurring on national-forest protection areas during 1949, tank trucks were used on 2,382 fires or about 22 percent of the total. They were used as the primary means of initial attack on 1,281 fires and of this number assured control of 1,001.

TESTS SHOW CIGAR AND CIGARETTE STUBS COME DOWN HOT

H. T. GISBORNE [1]

Ever since airplanes began flying over the forests there have been lively discussions as to whether or not burning smoking materials thrown from an airplane might start fires. Recently, Mr. C. M. Johnson, assistant director of Keep Washington Green, Inc., asked us the direct question: "Can lighted material (meaning smokes) thrown from a plane ignite forest materials?"

We had some facts, based on tests that Bevier Show and I made back in 1922, plus at least 100 trials I have made since then. Those tests showed that all sources of heat as large and as hot as the coal that breaks off a hand-rolled cigarette would ignite dry, rotten wood.

We also had enough cases to justify the opinion that on loose duff or crushed-down dead grass, a hot pipe heel was most dangerous, a hand-rolled cigarette second, and a "tailor-made" third. No tests with cigars were made.

The reason for the above order of danger lies in the fact that a pipe heel or coal from a hand-rolled, which usually breaks off, is likely to filter down into the duff or grass where it touches more pieces of fuel and where more of its rising heat is effective in warming material above it. The "tailor-made," by contrast, more frequently comes to rest on top the duff or grass, touching only two or three pieces of fuel. Most of its heat therefore rises up into the air where it dissipates quickly.

Even with oven-dry duff and grass, Show and I got very few ignitions from any source unless we turned a fan directly on the spot. And that, by the way, was the method used by the Bureau of Standards in their tests some 20 years ago. However, as the wind velocity at the grass roots or the duff surface under a tree or brush canopy is seldom more than 2 or 3 miles per hour, we did not assume that much wind should be considered as normal. Under abnormal conditions almost anything can happen, of course.[2]

Hence, we had some basis for an opinion on the relative dangers of pipe heels and cigarette stubs on rotten wood, duff, and grass. We had

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[1] H. T. Gisborne, Chief, Division of Fire Research, Northern Rocky Mountain Forest and Range Experiment Station, died November 9, 1949, while making a study of the Mann Gulch fire on the Helena National Forest, Mont., in which 13 men lost their lives on August 5.

Mr. Gisborne was internationally known for his pioneering work in measuring and rating weather factors which influence the behavior of forest fires. He developed the system of measuring humidity, fuel moisture, precipitation, and wind velocity which can be translated into numerical terms of fire danger, known as the forest fire danger meter. He designed weather instruments now widely used on forest fire weather stations.

In November 1947, Secretary of Agriculture Clinton P. Anderson personally presented Mr. Gisborne with a silver medal emblematic of superior service to the Government, in recognition of his great achievements during the past 25 years in forest fire control research.

[2] Nothing in this report can be interpreted to minimize the danger of forest fires from people smoking in the woods, either on foot, horse, or driving through them. Millions of cigarettes are smoked and flipped by such people. Even if the chances are 500 to 1 against ignition, careless smoking can and does cause thousands of fires each year.

no facts, however, as to what would happen to any hot smoking materials thrown from an airplane. So on October 26 Fred Stillings rounded up enough smoke jumpers to corral a fair-sized fire, and with 3 men in the plane to do the smoking, and 6 or 8 of us on the ground to see what came down, we made some tests at Hale Field in Missoula. A dozen halves of 5-cent cigars and 40 good cigarettes were lighted and thrown from the plane.

With the plane flying at about 120 miles per hour and 500 feet above ground, we could see both the half cigars and the full cigarettes coming down; but when the stubs were thrown out at 1,000 and 2,000 feet, that was very difficult. Furthermore, the condition of 2 of the cigars recovered indicated that either the impact of the 120-mile wind or a hard bump against the fuselage or tail surface of the plane may have torn some of the stubs into small bits. We recovered only 3 of the 12 half cigars and only 25 of the 40 cigarettes thrown out. Of these, all 3 cigar stubs were hot enough to burn holes through the paper toweling on which we tried to catch them. Twenty of the 25 cigarettes recovered, or 80 percent, were likewise hot when caught or picked up.

The condition of some of the hot cigarettes was perhaps significant. The tobacco was burning back inside the tube of paper, which itself was not even scorched on the outside. This may have been due to the cool temperature and moderately high humidity of the hour when we made the tests. It may be, too, that the cooling of the paper surface even when falling through hot, dry air is sufficient to keep the paper from heating to the ignition temperature. Whether or not this adds to the ignition danger is anybody's guess. It seems evident, nevertheless, that the hot coal being inside the paper tube is thereby prevented from breaking off on landing, and then falling down into the duff or grass where its heat is most effective.

Our pilots pointed out one other significant fact, to wit: Even if the plane has a door or window which can be opened, it is not only difficult to open the door against the slip stream but it is dangerous to the plane. Most pilots will be quick to realize that the hot ember may be blown back into the plane or may lodge in a point in the tail assembly and cause damage. The chance of the ember being blown back into the plane was demonstrated in our tests by Floyd Bowman's pants. His wife had to darn four or five holes burned in them.

From these few preliminary tests the answer to Mr. Johnson's question appears to be: Yes, lighted material thrown from a plane can ignite forest materials. But the chances are very small if the ember lands on any material except dry, rotten wood.

MECHANICAL FIRE HAZARD REDUCER

Ed Ritter

Forester, Region 7, U. S. Forest Service

A firm at Fitchburg, Mass., has manufactured and put on the market a portable wood chipper which has created considerable interest in the Northeast. Some of the models may be mounted on light trailers although others are built for mounting on trucks so that "progressive" chipping might be made easier. Cutting blades are of five sizes: 5, 6, 9, 11, and 14 inches. The one I observed was being tried out by the Connecticut Park and Forest Commission. It had a 6-inch blade, was mounted on a light trailer, and was powered by a Wisconsin air-cooled, four-cycle, V-4 motor. I was told by a representative of the company that this machine retails for $1,970.

Figure 1.—Portable wood chipper in use. Chips may be blown 15 or more feet from machine to remove debris from roadway or direct into a truck for carting away.

Wood chips might be used for a variety of purposes, such as mulch for strawberry plants, bedding in dairy barns, poultry and hogpens, and as a source of compost material. Highway crews could make use of a chipper in disposing of brush along rights-of-way. Recreational

maintenance crews might use chips in stabilizing slopes and sandy light soils when heavy use tends to churn up the ground. However, my principal interest in a chipper lies in its ability to dispose of brush as a fire-hazard reduction measure.

Ordinarily, there is little need to burn or otherwise dispose of the usual accumulation of hardwood brush. Coniferous material is more hazardous and is often burned during safe seasons. The 6-inch chipper observed in operation literally "eats up" soft or hardwood brush and slash up to 4 inches in diameter. Chips may be blown into a truck and hauled away or scattered along the roadside as the operator chooses.

My observations have not been sufficient to determine what the cost might be as compared to piling and burning or other means of brush disposal. But considering the soil-building possibilities and various other uses of wood chips, the net cost chargeable to fire-hazard reduction might be fairly reasonable.

Corrosion of Metals by Wet Water.—One of the problems encountered in using wetting agents is increased corrosion in fire-fighting equipment. An experiment conducted at the California Forest and Range Experiment Station shows that a readily available chemical can be used to reduce corrosion.

The test was made to determine the corrosive action of wetting agents upon 24-gage iron and galvanized iron. These metals were selected because they are used in construction of tanks for back-pack pumps and for some fire trucks. Strips of the metals (½ by 4 inches) were cleaned, weighed, and immersed in test tubes containing wet water solutions. Potassium dichromate, a known inhibitor of corrosion which does not affect wetting properties, was added to four test tubes, two with water and two with an agent. Each received 300 parts per million of potassium dichromate (about 0.04 ounce per gallon). At the end of one month the strips were removed from the solutions, cleaned, and weighed to determine corrosion losses.

Tests with iron and 13 wetting agents revealed that 6 of the agents had higher corrosion losses than plain water. Some of these agents may contain inhibitors; one that is known to contain a dichromate salt had a corrosion rate lower than water. Adding potassium dichromate to plain water reduced its corrosion rate on iron by 10 times. This inhibitor reduced corrosion of one of the tested wetting agents by about 10 percent.

Tests with galvanized iron revealed that all but 3 of the 13 wetting agents had higher corrosion rates than plain water. Potassium dichromate was very effective in reducing the corrosion rate on galvanized iron. The agent known to contain a dichromate salt had a corrosion rate three-fifths of that for water alone. Adding potassium dichromate to plain water reduced its corrosion rate on galvanized iron by 5 times. Most important, this inhibitor reduced corrosion of one of the tested wetting agents from twice that for plain water to two-fifths that for water.

In general, it was found that galvanized iron is more readily corroded by wetting agents than is the iron. The zinc coating probably reacts more easily with the chemicals in the wet water solutions.

The test indicates that corrosion rates increase with increase in acidity of the solutions. Adding potassium dichromate to plain water or to a wetting agent solution increases their acidity; but due to the formation of a protective coating by the dichromate, corrosion is decreased. One precaution must be observed when using potassium dichromate—it is a poison, and water treated with it should not be used for human consumption.—ROBERT S. MCBRIDE, *California Forest and Range Experiment Station.*

HELICOPTERS AND RADIOS ON THE STANISLAUS NATIONAL FOREST

ALLEN F. MILLER

Forest Supervisor, Stanislaus National Forest

The effective use of helicopters can be greatly increased by close coordination with radio. This was demonstrated on the Walton Spur fire on the Stanislaus National Forest during August 1949. The equipment used was a Bell two-place (pilot and passenger) helicopter, and KUT2-KUR, UT-UR and SX-type radio.

The fire burned in the steep inaccessible Tuolumne River Canyon at the mouth of the Clavey River. Elevations on the fire ranged from 1,200 to 3,500 feet. Jawbone Ridge, a steep narrow divide between the Clavey River and the main Tuolumne River, was inaccessible except by foot travel through heavy brush.

It was possible to get to the top edge of the canyons by road, but travel into and out of the steep rugged canyons was by foot. This foot travel was slow and dangerous. The fire was handled in two parts because of the inaccessible canyon, but the radio communication enabled one helicopter to service both parts.

Both the Clavey and the Tuolumne Rivers were low at the time of the fire and numerous sand bars were exposed. These sand bars were later used as landing spots for the helicopter. Landing spots were also prepared around the perimeter of the fire and on Jawbone Ridge. Once these landing spots were developed, movement of men became quick and effective. Travel by helicopter from Walton Spur spot No. 1 to Groveland spot No. 2 required 10 minutes. The same trip by car required 2½ hours. Five men were moved in five trips from Walton Spur spot No. 1 to Jawbone Ridge spot No. 3 in 38 minutes. Travel by car and foot would have required 2½ hours. The last 2 miles on foot would have been through steep brush country. By using the helicopter, the men were fresh upon arrival on the fire. On another occasion, 22 men were moved in 72 minutes to Jawbone Ridge. It required slightly over 3 minutes for a round trip. Each man carried his own fire-fighting tool and when he arrived on Jawbone Ridge, he was fresh and ready to work. He only had to walk a short distance to the fire line and went to work immediately. The first man was on the fire in 3 minutes and the crew was built up rapidly. The travel time by truck and foot would have required more than 2 hours.

All direction of the helicopter was by radio. KUT2-KUR sets were placed at all operating landing spots near the fire camps and SX sets were used on the isolated spots. One UT-UR type was used in the Bull Meadow fire camp A. The helicopter was not equipped with radio. The first man to land on an isolated spot carried a radio, and communication was immediately established with his home base. This

proved very useful as it was possible to determine the needs of the crews and to return the crews when necessary. It avoided long delays or unnecessary trips by the helicopter to contact these isolated landing spots to determine needs.

By having radio communication between the landing spots, the helicopter was shuttled between spots to accomplish needed missions and there was very little stand-by time. The helicopter was on the fire 6 days and there was a possible flying time of 63 hours and 53 minutes. It actually flew 44 hours and 5 minutes or 69 percent of the time. There were only 3 hours and 7 minutes of stand-by time. The rest of the time was spent refueling and repairing the helicopter and feeding and resting the pilot.

The helicopter-radio combination was used very effectively in removing a badly burned man from the fire line. The accident occurred about midway up the steep canyon slope. An SX radio was

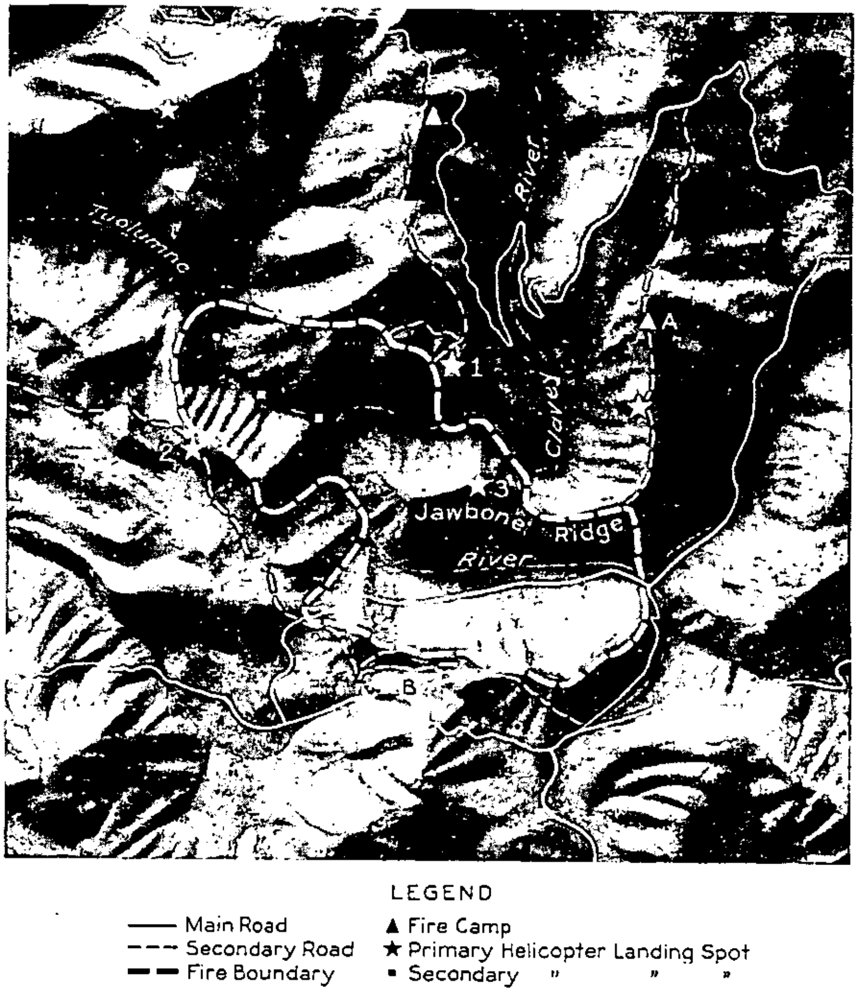

FIGURE 1.—Walton Spur Fire on the Stanislaus National Forest, August 1949.

sent to the crew aiding the injured man. They decided to move the man down to the river to a sand bar and have the helicopter transport him to the hospital at Sonora. They radioed that they needed a stretcher. One was dropped to them by the helicopter. The progress of the crew was reported by radio to the Groveland fire camp B as they made their way toward the river. Steep rocky bluffs near the river stopped their progress until 300 feet of rope could be dropped to them. When they reached the river, the helicopter was waiting for them and the injured man was immediately transported to the landing spot near Groveland. The doctor had advised against transporting the injured man to Sonora by helicopter because of the danger from shock.

Late on the fifth day of the fire it was decided to burn out along the Clavey River on the Jawbone Ridge side. Men were flown to a sand bar in the Clavey River and stationed along the river bank. Then lighted fusees were dropped from the helicopter and completed the burn-out. Of 17 fusees dropped, 15 set backfires. One landed on a rocky ledge and the other was snuffed out by the fall.

A planned system of landing spots located on strategic points throughout the forest would greatly increase the early effectiveness of the helicopter. These spots should also be radio-checked with the forest radio net, and all other things being equal, selected on the basis of their radio suitability. A radio set in the helicopter would be desirable, but not essential.

With careful correlation between helicopter and radio, the effectiveness of both these tools in fire control can be greatly increased.

INDIVIDUAL SUBSTATIONS FOR MAIN OFFICE RADIO

CHESTER E. LYONS

Engineering Aide, Communications, Deschutes National Forest

After our initial installation of FM radio on the Deschutes National Forest, Bend, Oreg., we soon became aware that a remote unit for the administrative assistant and one for the fire assistant did not provide good communications. Often they were left unattended or turned so low that calls were missed. Nearly as bad were the work interruptions as people leaned over the desks to use the sets. We use radio the year around to contact two of our ranger stations, and our

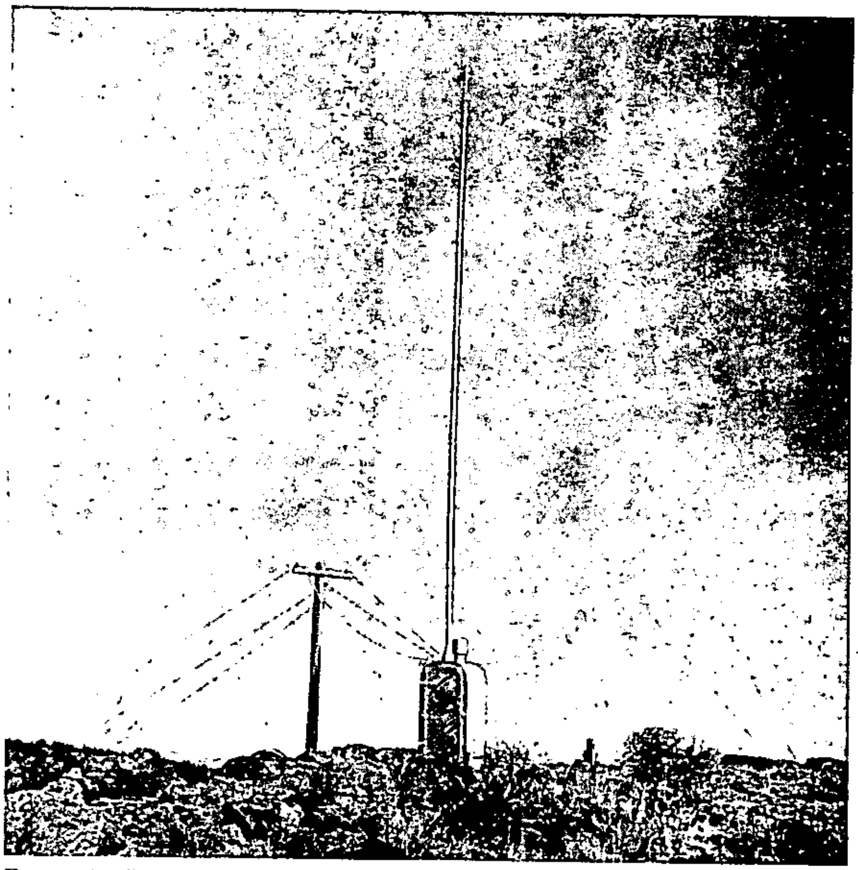

FIGURE 1.—The remote unit set-up is bolted to a concrete slab; the ship doors are bulletproof.

timber-sales program is quite active. With radios on nearly all lookouts and a fair-sized fleet of mobile radios and portable sets, the unceasing "yammer" from the two remotes became a real problem.

We solved the problem by putting one of the remote units on the receptionist's desk, and from this point wired substation sets to the supervisor, administrative assistant, fire assistant, and the timber management, clerk, and engineering personnel. Each of these substations was provided with a buzzer signaling circuit. The second remote unit was not used.

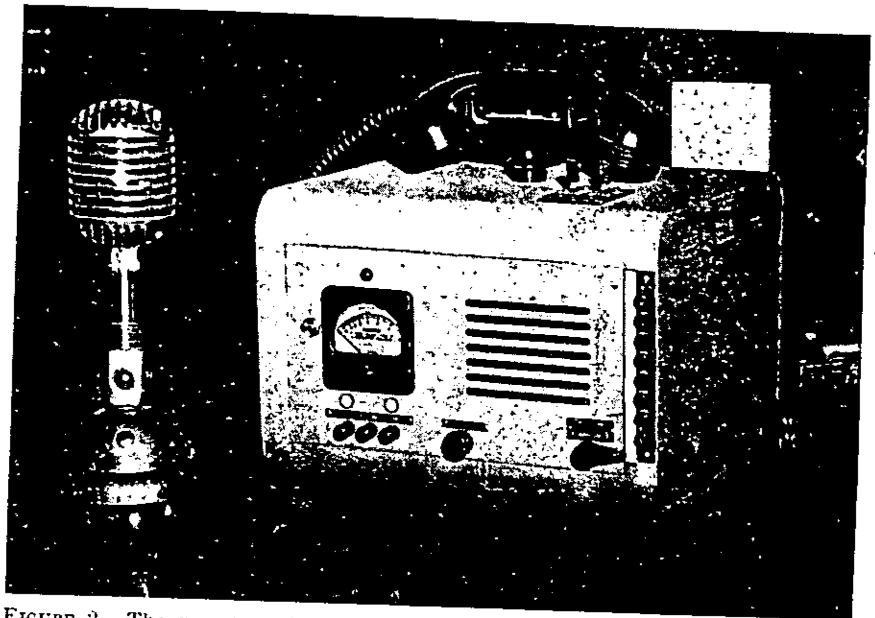

FIGURE 2.—The remote unit; buzzer system buttons on right of panel; risers have been added to handset cradle so push-to-talk switch will clear.

Briefly, our set-up consists of a 50-watt Motorola transmitter that, with the receiver, is housed in a steel box located some 3 miles out of town on a rocky knoll (fig. 1). A 500-ohm telephone line connects the main office remote unit with the set. Another remote unit is wired in parallel across the 500-ohm line to the ranger's office in another building.

The development of the substations was shelved, twice. At first it was discarded as impractical—too many unshielded leads in conduit under the floor, prohibitive cost, and plain unorthodox practice. We picked up the idea again, only to be stopped cold by the cost of commercial push-to-talk handsets. Finally, we acquired several condemned EE-8-A Signal Corps telephones and with the handsets from these phones set to work. It was found necessary to install Western Electric F1 transmitter units in the handsets to achieve maximum, uniform output. Some handsets are already so equipped. The receiver units were found to be comparable to commercial products.

In figure 2 the buttons for the buzzer signaling circuit are on the right front of the panel of the remote unit, two switchboard keys

have been installed on top of the unit, and a handset rests in its cradle, also located on top. Figures 3 and 4 show the location and size of the piece of equipment needed to connect the substations to the remote unit. Figure 5 shows a substation fastened to a desk. Both the box and switch hook are used pieces of telephone gear. The new non-kinking cord on the handset was used, as the old original cord was much too long.

Disregarding the wiring for the signaling circuit, three wires are used to connect the substations to the remote unit. The substations are wired in parallel across these three common wires. Probably the most surprising thing about the substation circuits is the fact that no further provision of current is needed to drive the F1 units in the handsets.

The dynamic microphone in figure 6 is normally connected with the "hot side" of the microphone going directly to the grid. The switch on the microphone completes the circuit to ground, closing the relay. Current to energize the microphone comes through a resister in the grid circuit. This explains why the switch Sw 1 is needed. It is a switch to take the dynamic microphone out of the circuit. Without this switch the microphone would be "hot" whenever the relay in the remote unit was closed by a substation handset, picking up random noises, typewriter clicks, and conversation. However, through this same circuit the current for the substations is provided.

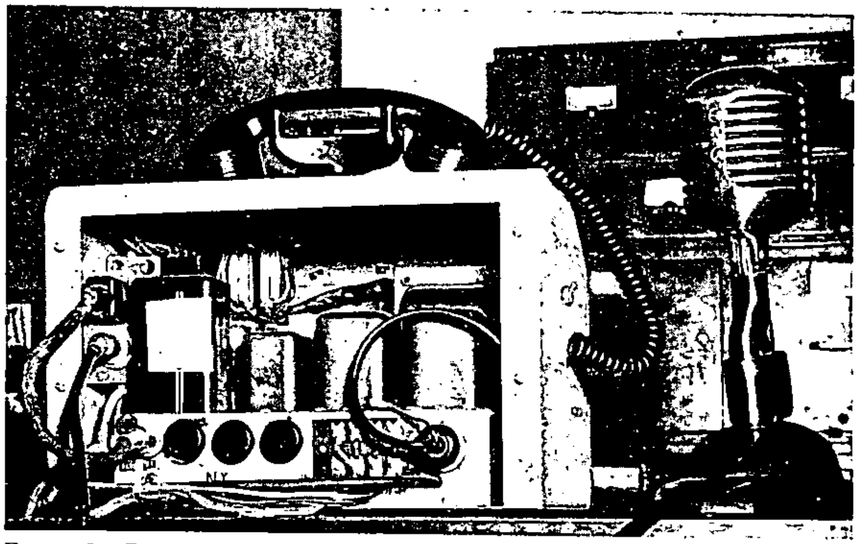

FIGURE 3.—Rear of remote unit with plate removed. Microphone cable goes to added unit. Interunit cable connects added unit to remote unit. Note on relay cover reads, "The only actual change in this remote unit is the removal of a jumper in the Xtal mike plug from # 3 and # 4."

The speaker switch Sw 2 acts as an additional mute circuit. Closing this switch cuts off the speaker, and the signal is heard in the handset even though it is resting in the cradle. The signal heard in this manner is much the same as with any telephone off the hook. It provides ample volume for standby without filling the room full of

sound. The addition of the handset to the remote unit also gives the receptionist a choice of operation. During times when her room has visitors, it allows her to carry on radio conversation as unobstrusively as answering the telephone. For her normal dispatch of traffic, however, she has found the dynamic microphone to be more convenient. The cradle for the operator's handset is wired so that the speaker is cut off and the signal is heard in the handset in the "off cradle" position. (The make-and-break action of the cradle must occur as shown when the handset is in the "in cradle" position.) Both the operator's handset and cradle were manufactured commercially.

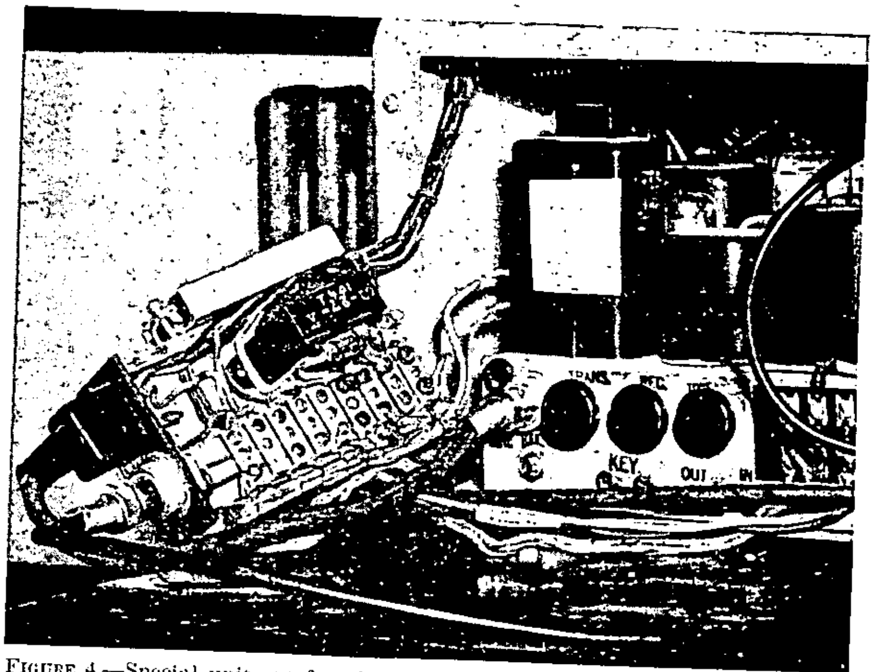

FIGURE 4.—Special unit out for observation. The sidetone condenser is on top. The impedance matching transformer is placed between the condenser and terminal strip.

We rewired the action of the handset as shown and made some revisions in the cradle to get the desired action. However, this handset could have been another EE-8-A handset and mounted in a box. In fact, the microphone and speaker switch, the equipment that connects the remote unit to the substations, could all be installed in some sort of external unit. The interunit wiring is not critical.

The condenser C1, in figure 6 serves the same purpose as the condenser in figure 7. These condensers prevent an accidental DC voltage from spoiling the receivers in the handsets. Condenser C2 however, has an entirely different function. It serves to provide sidetone to the substation system, allowing both sides of a conversation to be heard from any substation handset, thus providing facilities for three-way conversations.

We tried a lot of transformers to properly match impedances, and finally found one among some spare parts with a 1,000-ohm primary and a 35-ohm secondary winding. It matches the external speaker output of the remote unit (terminals 1 and 2) well enough that even with all six of the substations off the hook and in the circuit, no noticeable drop in signal strength is heard. Roughly, this means that twice the number of handsets that we are using could be employed in similar systems. The U. S. Forest Service Radio Laboratory in Portland, Oreg., has the complete data on this transformer.

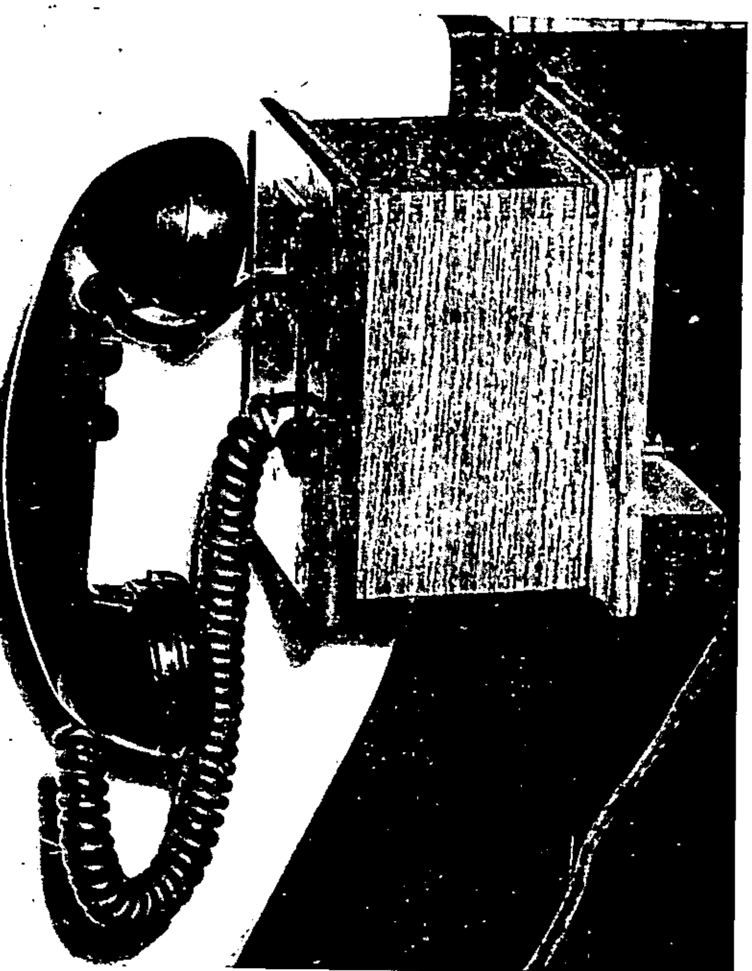

FIGURE 5.—One of the substations. Old ringer boxes, made of durable hardwood, are fine for size. The condenser, hook-switch, and wiring are inside.

Figure 8 shows a remote unit and two substations complete with buzzer signaling circuit. Note that eight wires are needed to completely connect these three positions. For each additional position, another wire must be added to the signaling circuit. We have four

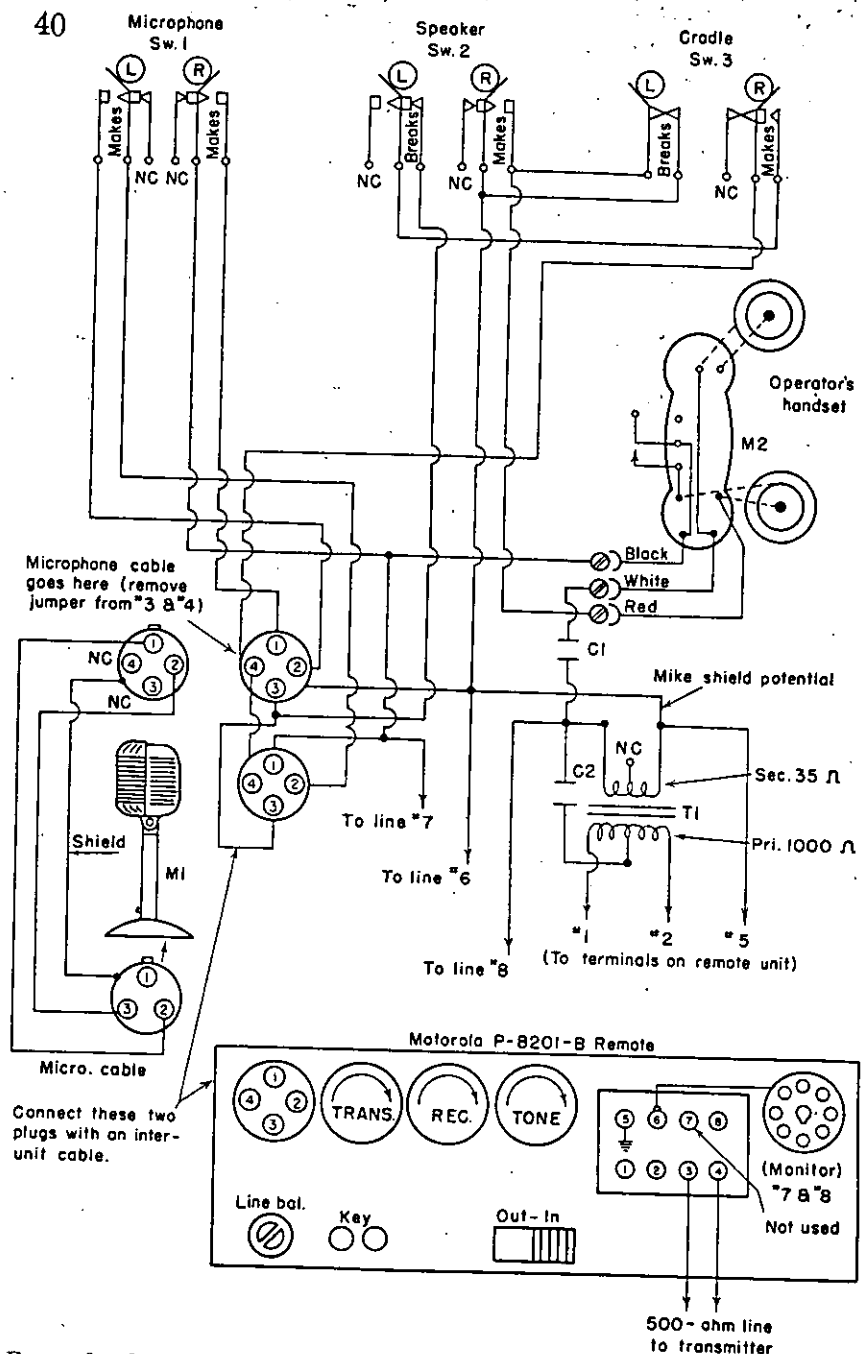

FIGURE 6.—Operator's circuit. Some of the parts are: Sw 1 and Sw 2, key, switchboard "Kellogg" No. 1028; Sw 3, cradle, telephone handset "Monophone" (revised); M1, Model 55 microphone, crystal dynamic "Unidyne" (furnished with remote unit); M2, handset, telephone push-to-talk "Monophone" (revised); C1 and C2, condensers, Western Electric No. 149E 1 mfd.; T1, audio transformer, No. S-27-X (any small transformer with approximately 1,000-ohm primary winding, center tapped, and a 35-ohm secondary winding). Also needed are two female and two male microphone receptacles to make up the interunit cable.

more substations than shown in this diagram; consequently, we use twelve wires in conduit under the floor. The system picks up just enough hum for one to be aware of it when our carrier is unmodulated. It is no more than that and is definitely no trouble.

This system can be hooked up experimentally by any technician using parts from his stock. The wiring of the remote unit is left completely undisturbed. The only actual change that is made to the remote unit is the removal of a jumper wire from terminals 3 and 4 in the microphone plug. The method of adjusting the "Trans" control knob is a little different, due possibly to the condenser C2.

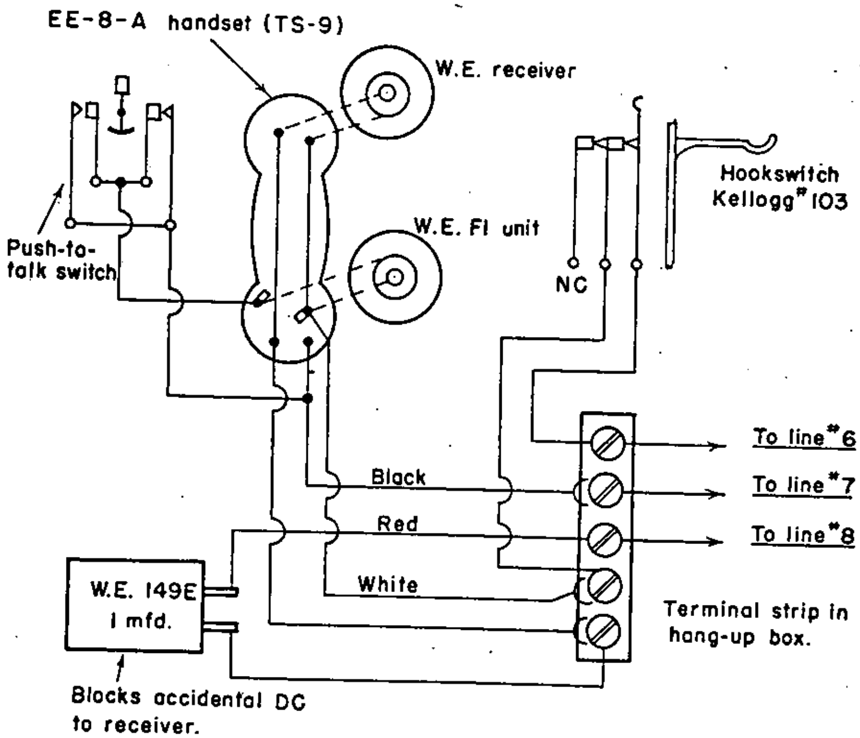

FIGURE 7.—Substation circuit.

Oscillation occurs if the "Trans" knob is advanced too far causing the DB meter to swing off scale and the outgoing signal to be blurred. With the dynamic microphone switched out of the circuit, close the relay in the remote unit by pushing the push-to-talk switch on any of the substation sets or by the push-to-talk switch on the operator's handset. Observing the DB meter, adjust the "Trans" control (handset unmodulated) so that the needle on the meter rests in its normal left-hand position, in other words, so that the needle is quiet. This setting may be found to be too much for the dynamic microphone. If this happens, have the operator speak in such a way as to average zero DB on the meter. It will be about right for the F1 units in the handsets as these will vary with loud and soft voices, distance from

the mouthpiece, etc. Adjust the receiver signal at the remote unit as desired. Adjustments here will not vary the handset signal enough to be noticeable.

The actual cash outlay for parts to complete our whole substation system came to less than 10 dollars. The buzzer system had been installed years before. We rewired it (as shown in fig. 8) in order to use less wires than had been used originally. If substations of this type are contemplated and all parts and boxes must be purchased, the cost per substation will run about 8 dollars. The saving will be appreciable if the cost of a like commercial product is considered. We could find nothing similar for less than 35 dollars each.

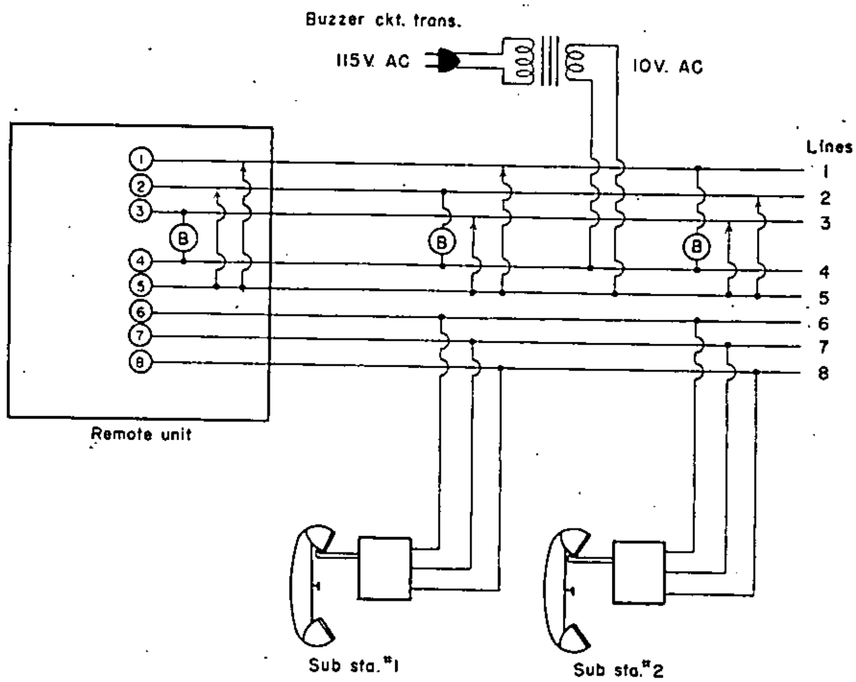

FIGURE 8.—Remote unit and two substations complete with buzzer signaling circuit. The buzzer circuit transformer is an ordinary doorbell transformer.

The buzzer signaling system buttons and buzzers can be obtained almost anywhere. With the exception of the buttons installed on the remote unit (done this way for the receptionist's convenience) our buttons are in little block affairs that go nicely in a drawer. The buzzers are fastened under the desk.

Our substation setup is only one of many variations that are possible. A similar system can be devised to control almost any type of gear.

Further information on this installation may be obtained by writing the author on the Deschutes National Forest, Bend, Oreg. Also, we are interested in hearing from any forest that makes such an installation.

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page. The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the legend being separated from the text by lines both above and below. Illustrations should be labeled "figures" and numbered consecutively. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

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