ECEMBER 6 1937

FIRE CONTROL NOTES

A PUBLICATION DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE - U. S. DEPARTMENT OF AGRICULTURE

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WHAT FUTURE HAS FIRE CONTROL NOTES?

Amazing results may be produced by cooperation. Accomplishments by the AAA and labor and business groups are determined primarily by the degree to which the principle of cooperation is applied. The world of science would be relatively barren without the highly developed cooperation which has grown up among scientists. Where the spirit of cooperation has been well developed, fire control has an effectiveness which does not otherwise exist. Cooperation or the lack of it will make or break FIRE CONTROL NOTES.

If workers in fire control take a pride in this publication as the organ of their occupational group, they will be critical of published articles having only a mediocre quality; if they feel an individual share in the collective responsibility for the character and quality of FIRE CONTROL NOTES they will be on the alert for chances to make, or get others to make, contributions which will be appreciated by readers concerned with the new science and art of fire control. When they find published articles of value to them individually, they will be impelled to respond by distilling from their own work the things which, if written up, would be of value to others.

The time has come when the publication will inevitably have tough going. The men most willing to contribute have done their share. The material most easily put in shape for publication has been printed. FIRE CONTROL NOTES will naturally feel the tendency to peter out. But it will take the upgrade promptly if workers in fire control really desire a publication devoted to that subject and cooperate to make it worthwhile. Will you individually do your share?

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CONTENTS

FIRE CONTROL NOTES

DECEMBER 6, 1937

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 technology may flow to and from every worker in the field of forest fire control.

CORRELATION OF REGIONAL FIRE DANGER RATING SYSTEMS

George M. Jemison

Associate Forester, Appalachian Forest Experiment Station, Asheville, N. C.

The pioneering of Gisborne and Shank has led to active interest in all Regions in the development of reliable devices for measuring and integrating the elements of fire danger. Without the aid of such devices a manager of fire control lacks command of facts which are essential to successful performance of his function. But much of the value of such devices will be lost unless they are so related to each other that fire danger can be correlated and compared for different types of country and different combinations of fire danger factors. In most Regions and for the country as a whole we now rate fire days as easy, normal, or bad. Human nature being what it is, our easy periods tend to be rated as normal, our normal ones as bad, and our really bad ones fail to be recognized as such. In a stimulating way the author discusses possible means of putting this sort of loose thinking behind us. With good response from other students of the subject our mastery of this problem should be speeded up.

The numerical system of rating fire danger[1] as originated by Gisborne in Region 1 has proved to be such a valuable aid to presuppression and suppression that all Forest Service Regions in the United States are committed to the development of danger rating schemes. Such schemes are useful in determining the number and distribution of men needed for effective fire control from day to day as fire danger fluctuates.

Not only is the daily rating of fire danger valuable, but administrators who wish to rate the relative efficiency of several fire control units or of any one unit for several years also find expressions of the severity of the entire fire season essential. Quality of fire control can be accurately rated only if statistics of number of fires, area burned, and cost are compared with ignitibility and combustibility of fuels as measured and expressed numerically.

[1] In this discussion, "fire danger" expresses the total of all temporary dangers that affect ignition and combustion; that is, abnormal occurrence, fuel condition, and weather.

Numerical danger ratings are definitely useful in fire prevention work, and great publicity value has been attached to them. In Region 1 the public is learning to think and talk classes of fire danger and, through newspaper reports during the past two fire seasons, has obtained a better understanding of danger. Furthermore, ratings of the severity of a fire season are essential considerations in determining the effectiveness of fire prevention campaigns. A reduction in number of man-caused fires may not be significant if accompanied by a decrease in ignitibility and combustibility.

Advantages of a national danger scale

Most of the advantages that apply to each of the regional danger rating systems also apply to a national danger scale and make the latter an essential for sound fire-control administration. Much can be gained by rating fire-control efficiency throughout the country, and certainly the publicity value of danger ratings can be capitalized upon nationally. While regular financing for fire control depends upon analysis of permanent dangers and normal conditions of fuel and weather, there will always be a need for distributing a varying amount of money from year to year, depending on the fluctuating temporary dangers in each region. The relative need for such funds can be determined only on the basis of a national danger rating scheme.

Limitations in the type of danger rating system

A single, universally applicable danger meter or similar device is out of the question because danger factors vary, or in some cases differ in relative importance from one place to another. For example, the occurrence of lightning storms constitutes a danger in the West, but does not in parts of the East where leafy hardwood stands are usually safe from fire during periods when lightning is frequent. In addition, inherent differences in the fire control problem among regions necessitate different steps in organization, hence require fire danger rating systems with different numbers of classes.

It is also impractical to construct danger meters for each region that rate danger in classes representing similar rates of spread. The great differences in rates of spread in fuel types existing in the several regions preclude the possibility of having class 5, for example, universally indicate the same spread in chains of perimeter increase per hour. This is indicated by a recent analysis of Region 7 fire reports[3] for the years 1930 to 1937, which shows that fires in even the slowest spreading fuel types in the

[3] Abell, C. A. Rate of spread and resistance to control data for Region 7 fuel types. September, 1937. Mimeographed report, Appalachian Forest Experiment Station, Asheville, N. C.

region on an average day spread from 10 to 20 chains per hour faster than fires in the "extreme" rate-of-spread fuels in Region 1 on an average bad (class 5) day. Such differences make it impractical to aline Region 1 and Region 7 danger classes in regard to rate of spread. In statistical terms, the ordinary rates of spread of fires in the two regions represent different "populations."

Possible methods of expressing danger universally

A percentage expression of danger offers the best possibility of correlating various regional danger ratings and arriving at a national expression of severity of a particular fire season. Percentage ratings fill the requirements demanded of a national scale in that they are easily understandable by laymen and technical fire control men alike and express danger in exact and concrete terms, eliminating the possibility of personal differences in interpretation.

Percentage of numerical range: Perhaps the simplest method of determining the percentage danger rating for each region is by referring to the lower and upper limits of each numerical scale, equating them to zero and 100 per cent, respectively. In the southern Appalachians, for example, under this system class 5 will equal 100 per cent; in Regions 1, 6, and 9, class 7 will equal 100 per cent. In all cases mentioned class 1 represents zero per cent.

The bad feature of such a scheme is that never could this entire range from zero to 100 per cent be experienced. Actually, over a period of years, average seasonal danger would fluctuate between, say, 40 and 75 per cent. It would be difficult to visualize the relation between a 50 per cent rating and one of 60 per cent.

Percentage of normal danger: Expression of danger as a percentage deviation from a normal was first mentioned as a possible method of correlating regional danger ratings at the Mt. Shasta fire research meeting in 1936. In favor of normals is the fact that most people are accustomed to their use, and certainly plus or minus deviations would emphasize direction of departure from the average danger. It is difficult to interpret, however, how much worse a plus 20 per cent rating actually is than a plus 10 per cent deviation.

A disadvantage in the use of a normal as the basis for rating danger is that a unit of minus deviation may not span the same range of danger as a unit of positive deviation. As an illustration, suppose that in the southern part of Region 7 average danger is represented by class 2.8. On the scale of 1 to 5 that is being used, the greatest deviations possible would be, theoretically, minus 64 per cent and plus 79 per cent. (Of course, actually they would be much less, because an average of class 1 or class 5 would never occur.) Only if the normal happened to coincide with the midpoint (class 3) of the range 1 to 5 would minus deviations be comparable to plus deviations.

In some cases it would be difficult to establish a normal danger class. Judgment cannot be relied upon to assist greatly in selecting the average where actual records are lacking because a season of normal danger rarely exists and is quite intangible to most men.

Percentage of "worst known" danger: At the Elkins meeting of fire control planners it was suggested that danger might be expressed as a percentage of "worst known danger." Theoretically, each region would find the worst year on record, compute the average danger class for that year, and thenceforth use this danger class as the 100 per cent point. No danger (class 1 on most scales) or "least known danger" could be used as the lower or zero per cent limit.

This scheme has the advantage of keeping severity ratings within the scope of probability. At least it would be possible to have years that rate from zero to 100 per cent. Therefore, the significance of the difference between two specific ratings would be much easier to visualize.

The average danger for the worst known year might not be a reliable base in some regions where danger meters have recently originated and are of such construction that past years cannot be rated unless actual fuel moisture measurements are available. In such cases ratings might need revision as years easier or worse than the "least and worst known" occurred.

Percentage of "worst probable" danger: One practical method of comparing units or years on the basis of a percentage danger rating has been demonstrated over a period of several years in Region 1. The method in use, developed and described by Gisborne,[3] converts the average danger class into per cent on a scale where 100 per cent equals a danger class called "worst probable danger" and zero per cent equals a class called "least probable danger." The limits which have been set up for July and August in Region 1 have been determined from records of the least and most hazardous seasons, augmented by the judgment of experienced men.

The Region 1 scheme, which really differs little from the "worst known" basis previously mentioned, could be expanded to operate on a national

[3] Gisborne, H. T. Measuring fire weather and forest inflammability. U. S. D. A. Circ. No. 398, 58 pp., 18 fig., July, 1936.

scale. In each region the limits of least and worst probable danger could be set upon the basis of actual past danger ratings plus experienced judgment. If the limits are correctly selected the per cents of worst probable, figured by every danger rating system, should be comparable. The regional per cents, weighted by the acreage that each represents, could then be combined into one figure expressing relative danger for the United States.

The feasibility of the whole plan depends upon whether or not the zero and 100 per cent points can be selected accurately. However, experience has indicated that this is not hard to do after a few years of fire danger measurements have been made. When field men become accustomed to rating danger on a numerical scale, their judgment is also a valuable aid in choosing the limits. Some of the danger meters recently developed in eastern regions are so constructed that they may be applied to old weather records, and ratings for past years can be obtained and used in determining the least and worst probable limits.

The Appalachian adaptation of "worst probable"

It might be possible to aline danger ratings following a scheme now being tried in the Appalachian Mountains and based upon Region 1's per cent of worst probable rating. Least probable and worst probable limits are at danger classes 2.0 and 4.0, respectively, for the Appalachian danger meter, which rates on a scale of 1 to 5. These limits, for the spring fire season, were selected on the basis of experienced judgment and actual ratings for past years. They bear the same relation to the total scale of 1 to 5 as the Region 1 limits (2.8 and 5.5 for July and August) do to the total scale of that danger meter, which is 1 to 7. Expressed as a proportion, $2.0:5 = 2.8:7$ and $4.0:5 = 5.5:7$. To illustrate the relation more clearly, the first expression would be read: danger class 2.0 is to class 5 (Appalachian meter) as 2.8 is to 7 (Region 1 meter).

It is not coincidence that caused the relative agreement of least and worst probable limits for the northern Rocky Mountain and Appalachian danger ratings. It seems entirely logical that the limits for any two systems should agree if the temporary dangers are properly integrated and if weather exhibits generally the same range of variation from the easy to the bad year.

Length of season

One important consideration necessary in rating danger and one not previously mentioned is the effect of length of season upon fire danger. If two regions have the same average fire danger, but in one the season lasts eight months compared to four months in the other, obviously the relative danger is not equal.

A method of bringing length of season into the severity rating is mentioned as a possibility. From records and experienced judgment, the "longest probable season" might be determined. Severity ratings in per cent could then be adjusted on this basis. For example, if a season that rates 60 per cent of worst probable danger lasts for four months where the longest probable season is six months, $4/6 \times 60$ equals 40 per cent, the adjusted rating. A 100 per cent rating for a season would occur only if the worst probable danger lasted for the longest probable time.

The foregoing suggestion is offered with the realization that the writer may be accused of putting the cart before the horse in proposing a way to correlate something that cannot as yet be measured. At least to his knowledge no satisfactory way has been propounded for measuring length of fire season. However, when we know the way in which a variable may be used, the development of a satisfactory way of measuring it is often easier.

Perhaps length of season could be arrived at by tallying the total number of fire days that occur, a fire day being recognized as any day that demands some special organization for fire control. On most danger rating systems this would mean class 2 or worse. Then, the ratio between actual number of fire days and the greatest probable number would indicate length of season. This feature takes care of duration of season only; severity ratings take care of degree of danger in the season. Together they should give a very complete picture of the fire danger experienced on any protection unit.

Discussion

Of the various methods that have been described for rating severity of a season on a national scale, the writer favors the "worst probable" basis. The use of judgment and experience in selecting the limits needed is not desirable. This system or any other system should be carefully checked and adjusted as data for future years accumulate. However, the writer does not believe it necessary to wait several years to develop and test methods of correlating regional rating schemes. Much can be gained by trying out different systems now, using judgment where actual figures are lacking.

It is suggested that other regions and experiment stations now checking danger meters or similar devices set up least and worst probable limits for their scales. If these limits can be established in the definite ratio described for the Appalachian Mountain region and still rate severity of a season logically, then a big step has been taken in bringing the ratings of various regions together.

Although past discussions have indicated that many workers feel the correlation of all danger rating scales will involve complicated mathematics, it is the writer's opinion that this part of the job will be relatively easy. The comparability of the several rating systems now in use is truly more surprising than their differences.

Recording Messages in Fire Camps—Keeping an accurate, usable, running record of messages sent and received in a large fire camp or at a message center on a fire is very neceessary. On going fires, it is often necessary to refer to messages which have previously been sent or received. Memory is unreliable and not transferable to the relief fire boss, camp boss, or other persons. In a fire camp of any size whatever this must take the form of a written record. A written record is also invaluable to a proper study of a fire at a Board of Fire Review.

Anyone who has compiled a message record for a large fire knows what a job it is if messages are kept currently in log books, on message blanks, or scraps of paper. On a fire in Region 5 in 1936, where as many as 1,300 men worked from a single camp, with two smaller camps usually operating at the same time, a regular "swing-arch" type of filing mount was used for recording messages. The filing mount was used on the customary letter-size board, but instead of being placed at the top of the board, it was attached in the middle. Regular radio message blanks and the memorandum (one-half letter size) pads were used. Holes were punched to fit the swing-arch and the pages were all torn off the pad before mounting. Carbon copies were made both of messages sent and received, and one copy given to the person concerned. The other copy was turned back to the top side of the arch and formed an orderly and chronological record of messages for use during a fire. For Boards of Review, significant messages were, of course, typed into a log form.—*C. R. Buell, Region 5.*

RATIOS OF PREVENTION COSTS TO OTHER COSTS

Fiscal Years 1934, 1935 and 1936

(R-10 omitted except in calculation of averages)

	EXPENDITURES ONLY					TOTAL FIRE CONTROL COSTS FOR PREVENTION, PRESUPPRESSION AND SUPPRESSION				
	Highest ratio prevention to presuppression		Lowest ratio prevention to presuppression		Average ratio (all Regions) prevention to presuppression	Highest ratio prevention to total Regional fire control costs		Lowest ratio prevention to total Regional fire control costs		Average ratio (all Regions) prevention to total costs
	Ratio		Ratio		Ratio	Ratio		Ratio		Ratio
FY 1934	R-5	81.07%	R-1	7.64%	34.24%	R-9	29.46%	R-4	5.74%	17.47%
FY 1935	R-2	129.58%	R-3	7.44%	35.48%	R-2	49.13%	R-3	4.89%	16.56%
FY 1936	R-2	48.93%	R-4	6.61%	22.81%	R-5	24.60%	R-3	3.72%	16.38%

SPECIAL POWER TAKE-OFF

F. W. FUNKE

Fire Equipment Specialist, Region 5

The standard power take-off furnished by motor car manufacturers was designed to carry heavy loads at low speed. It was intended to drive such units as hydraulic pumps for dump truck hoists, low-geared power winches, auxiliary transmissions, and various mechanical devices which require maximum torque at low speed of the driving shaft.

Probably the most important factor governing the design of the conventional power take-off is the size of the transmission gear with which the power take-off gear must mesh to receive its driving power. The size of this gear varies with the different transmissions used on the wide range of trucks available on the market.

The use of small water pumps with low horsepower requirement on tank trucks used in fire suppression work introduced a problem which could not be solved with existing equipment. Many of the small pumps required not more than 5 H.P. at maximum load. The ratios available in standard power take-offs required the engine to turn at one and one-half to two times greater speed than the take-off to secure a satisfactory pump speed on direct connected drive. This meant that the engine would be developing in many cases a speed equivalent to 30-40 H.P. to deliver a pump speed comparable to a load of not more than 5 H.P. Obviously, a drive ratio of this type is unsatisfactory from the economical as well as the mechanical viewpoint.

The cooperation of the Hercules Equipment and Rubber Company, of San Francisco, Calif., was enlisted in the development of a new type power take-off which would permit the maximum step-up in speed for a given transmission drive. Investigation revealed that such increase in driven gear speed is practicable in a few types of transmissions only. Fortunately, the Ford, Chevrolet and GMC T-16 truck transmissions, of which there are many in service in the field, are so designed that with suitable filler blocks a step-up power take-off can be mounted. The following ratios are available:

FORD AND ALL WARNER T-9 TRANSMISSIONS

Engine Speed	Power Take-off Speed
800 RPM	1130 RPM
900 RPM	1275 RPM
1000 RPM	1415 RPM

Chevrolet and GMC T-16 Trucks

Engine Speed	Power Take-off Speed
800 RPM	945 RPM
900 RPM	1050 RPM
1000 RPM	1170 RPM

The design is straight forward mechanical construction of the heavy duty type with ball bearing mountings. A conservative rating of 15 H.P. has been assigned to the take-off, and it should serve any transmission drive application. The power take-off is of much more heavy construction than the transmission case, and the latter really is the limiting factor in power applications rather than the take-off.

The standard power take-off is rated for intermittent service at 8-10 H.P., but heavy duty designs, which are constructed with roller or ball bearings, have been in service delivering 15-20 H.P. on tank truck pumps for many years. There is no data available to indicate the maximum load which may be driven by a power take-off mounted in the side of a transmission. To the best of our knowledge no failures have resulted in transmission drives requiring as high as 18 H.P. Such heavy loads are not recommended for continuous service, but may be delivered for intermittent periods without undue heating of the transmission.

A power take-off of this type used in connection with a standard drive tube and two oil-tight universal joints, as used on automobile drive shafts, will make an ideal pump drive unit. The drive shaft or tube should, of course, be of the slip joint variety.

Region 5 can furnish information as to availability of this equipment.

Hopes for Hovering Payload—Accompanied by photographic illustrations of fantastic mechanism, there appeared in a recent issue of Popular Science Monthly a brief article describing a giant helicopter. All air-minded fire control men have dreamed of a hovering type of aircraft which will carry real weight. The autogiro of today cannot do it, so let us hope the answer is in the offing. The article is quoted herewith.

Plans for a giant transatlantic helicopter, capable of flying twelve passengers from New York to Paris in less than ten hours, have just been announced by a French airplane factory. A pair of three-bladed "windmills" of eighty-foot diameter, whirling in opposite directions above the airplane-type fuselage, are to lift and propel the proposed craft. Rotated by four motors totaling 3,600 horsepower, they will give the vertical-rising amphibian a forward speed of more than 300 miles an hour. A preliminary model of 300 horsepower, but with two-bladed instead of three-bladed "windmills," has already been built to test details of the projected machine, which is declared to have been made practical by recent advancs in helicopter design.

—Division of Fire Control, Washington.

NOTES ON NEW RADIO EQUIPMENT

A. G. SIMSON

Radio Engineer, Forest Service Radio Laboratory

This article furnishes the latest information on two new types of radiophones developed at the Forest Service Radio Laboratory and now supplied by that unit.

Ultra-high frequency Type SV

Work on a revision of the type S, which is designated as type SV, radiophone has been completed except for the method of packing. It has greater transmitting power than, and numerous refinements over, the type S. The front panel of this unit is 6 by 10 inches and the depth 5 inches. The weight will be about 16 pounds, complete with all accessories but without external speaker, which is optional. Although the transmitting and receiving circuits are electrically independent, provision has been made for "simplex" operation only, as in the type S.

The transmitter power output of the unit is approximately 1 watt, as compared to 1/10 watt for the type S. The circuit employed is similar to that of the type S, with the addition of an electrical filter for improving quality of voice reception. Ballast tubes have been used in the type SV instead of the fixed resistors used in the type S. These ballast tubes eliminate the necessity of filament rheostats and automatically compensate for the gradual reduction in A battery voltage as the batteries wear out, thus materially increasing the service life of the A batteries.

An additional audio stage has been included to increase the volume to that necessary to operate a small loud speaker. The speaker is not incorporated directly in the unit, but provision has been made for plugging it in externally, thus allowing the SV to operate standby and in many instances serve as a direct substitute for the type T radiophone. Although the loud speaker will only be supplied on special request, headphones will always be included with the set.

All batteries will be attached to the set by means of a plug and socket arrangement, thus allowing the light-weight portable batteries to be removed and heavy duty batteries plugged in for permanent or semi-permanent installations. In order to increase the transmitting power it has been necessary to increase the "B" battery voltage on the SV to 135 volts.

The estimated cost of the SV, with portable batteries and without speaker, is $70. The speaker unit will be about $5 extra.

High frequency Type I

Following is the latest data on the type I radiophone, which was described briefly in the last Radio Equipment Bulletin.

The type I radiophone is a complete transmitter-receiver intermediate in power between the SPF and the M radiophone. It can only be operated from 6-volt storage batteries—not dry batteries—or 110-volt alternating current. The entire unit is mounted in a steel cabinet identical in size and shape to that of the 1937 model C, type M radiophone. In fact, the type I radiophone is primarily a modified M set for storage battery operation.

The receiver of the type I is a highly sensitive superheterodyne operating from the same storage battery source as is used to supply the transmitter. A vibrator type power supply similar to that in automobile radio receivers is employed in this receiver, thus eliminating the necessty for operating the transmitter dynamotor while receiving. The receiver does not use plug-in coils or band switching, and covers only the regular range of Forest Service frequencies, namely, 2900 to 3500 kc. A loud speaker is mounted in the front panel of the unit for standby service. A storage compartment for all accessories, such as dynamotor, antenna, halyards, phones, microphone, and telegraph key, is located in the rear of the cabinet.

The power rating of the transmitter is approximately 8 watts, as compared to 2 watts for the type SPF and 20 watts for the type M, and should provide a consistent working range of 25 or 30 miles and transmission up to distances of 200 miles or more under favorable conditions.

Current drawn from the storage battery is approximately 3 amperes for the receiver and 20 amperes for the transmitter. The transmitter employs the "push-to-talk" system, the same as that in the type M. The 20-ampere current is drawn only during the time the microphone button is depressed for actual voice transmission. The power output of the type I may be increased at any time to a maximum value of 20 watts by the substitution of a dynamotor of higher voltage and current rating. Such an increase in dynamotor rating will, of course, result in an increased drain from the storage battery of approximately 30 amperes. Thirty amperes is a very heavy battery load, and is not recommended except in unusual instances.

When installed in remote locations, storage batteries for the type I radiophone may be kept charged by means of any one of several commercially available gasoline-driven charging plants. Such plants weigh from 40 to 50 pounds and consume approximately ½ pint gasoline per hour.

In addition to its use at permanent and semi-permanent locations, the type I should fill an existing need for communication from fire trucks and other large vehicles. The estimated cost of the complete unit is $295.

ONE-WAY VERSUS TWO-WAY RADIO COMMUNICATION

W. M. OETTMEIER

Forest Manager, Superior Pine Products Company, Fargo, Georgia

The progressive organization of which the author is Forest Manager initiated the use of radio in fire control on private land. He knows that the one-way system operates with complete satisfaction on the forest lands under his supervision. Having read the editorial "leader" at the head of the article by H. J. Malsberger in the August 9 issue, he was prompted to make this apt presentation of the respective merits of the two systems. Incidentally, it is an able argument for applicability of the one-way system to conditions in many sections.

When considering the installation of radio as a means of communication in any fire protective organization the question of whether a one-way or two-way system shall be employed must be decided. Either type may be used to great advantage, but several controlling factors determine the decision.

Where the forest area is readily accessible by car or truck, and where a system of telephone lines can be constructed, one-way communication is sufficient, and the use of a two-way system can be a handicap as well as an unnecessary expense. Two-way communication becomes a necessity in mountainous regions, such as the Northwest, where quite frequently a smoke chaser must first locate a fire as to topographical position in order to direct fire-fighting crews over the shortest and best route. Also, in such areas, where fires often reach extremely large proportions and there is an absence of telephone lines, two-way radio is necessary to establish communication with base camps and headquarters.

The principal disadvantages in two-way communication manifest themselves in many ways. The transmitter in the field cannot very well be used in a mobile position unless the ultra-high frequencies are used, and these frequencies are good for only a very limited range. Considerable valuable time is lost in stretching out an antenna and getting into communication. and more time is lost in taking down the equipment and packing it up. Portable transmitting equipment must necessarily be of low power, yet it is quite expensive.

In order to operate a transmitter in any private service the operator must be licensed by the government, and to obtain such a license he must know enough about radio to pass an examination. In any two-way service the transmitters in the field should be tested at frequent intervals to see that they are working satisfactorily, which in itself takes up a considerable part of the time of men who probably should be doing other work.

One-way radio can and is being used with a high degree of efficiency on areas where a large portion of the territory can be covered by car or truck. In such cases receivers tuned to the transmitting frequency are mounted directly in the vehicle. Test calls are made by the fire dispatcher at frequent intervals merely to assure the man at the receiving end that everything is coming through and that his receiver is working.

When a fire call is sent out from the dispatcher to any crew working in the forest or to a ranger, the crew called can leave immediately and receive instructions while traveling. Ten to 15 minutes can be saved (an important factor on any fire) through this method, where it is unnecessary to first make several calls to get in communication, then take down and pack up portable equipment. Where radio is used it should never be considered as replacing the telephone, but should be used merely as a supplement thereto. In fact, the more telephone lines the greater the efficiency of the radio, especially when one-way communication is used. Crews carrying a small portable telephone, when summoned to a fire can call in from the first telephone line passed.

In using a one-way radio system several important factors must be kept in mind. The fire dispatcher must know at all times the approximate location of all rangers and crews equipped with radio receivers available for fire fighting. He must know that the receivers will be kept turned on during the hours specified and that the men will respond immediately to a fire call. Further, each person in charge of a radio-equipped car should report in by telephone if anything goes wrong with the receiver, even if this phone call necessitates a trip of 10 miles or more.

Receiver troubles are quite rare if the equipment is inspected once a month. If a test call is sent out every 30 minutes, a faulty receiver can easily be detected. After a few days' experience with such a receiver, however, one can tell almost immediately if something goes wrong with it, for when the receiver is working there is always a rushing sound from the speaker, and as long as this sound is heard one can be well assured that everything is operating satisfactorily.

In conclusion, it may be well to state again that both two-way and one-way radio communication have a place in fire protection. The two-way system, while probably a little more cumbersome and bulky, can be of more value in inaccessible regions. By some it may be thought that one-way communication is inefficient. On the contrary, where it can be used at all it is probably more efficient than the two-way system. A good example is the one-way system which has been in operation on the Suwannee Forest for approximately 4 years without a single failure. Fire losses during this period have been cut down to a very small fraction of 1 per cent, as against an average of 5 per cent before its installation.

A NEW FLOATING DISK COMPASS

H. M. White

Fire Control, Region 6

For years instructors at guard training camps had difficulty in teaching new men, and some of the old ones, how to use a quadrant compass. There were so many chances for error in reading this compass that fire executives were always afraid smoke chasers would go wrong when sent to fires where compass work was necessary. Then it occurred to somebody that the smoke chasers' compass should be graduated in azimuths, and for several years, in Region 6 at least, no quadrant compasses have been used by guards.

Changing to the azimuth graduation eliminated errors due to reading in the wrong quadrant when the needle settled near one of the cardinal points, and particularly when it settled between zero and the line of sight. The men still become confused, however, by the reversed position of the East and West markings, and there is a tendency to read the South end of the needle. The dial on the latest model carries a notation that the weight is on the south end of the needle, but the guard has to remember his instructions always to read the north end, and when running in a southerly direction he is apt to forget.

Last spring, Training Supervisor R. C. Lindberg suggested substituting for the compass needle a graduated aluminum disk with magnetized bar underneath, and he worked with a local instrument maker in designing a model. This compass has been shown to officers on a number of forests and has met with universal approval.

Just recently one of the standard smoke chasers' compasses has been changed to the disk type. Necessary changes were: removing the graduated ring and milling the inside of the case to give clearance for the disk, lengthening the pivot pin and substituting a jewel-mounted graduated disk and magnetized bar for the needle, putting in a new stop lever, producing the sighting line across the hinge and down to the glass, and inserting the ends of the metal ring holding the glass in holes drilled at either side of the line of sight so that this ring would not interfere with reading. It is estimated that compasses now on hand can be changed for $1.30 each in lots of 50.

The floating disk idea is not new, of course, but in other compasses of this type that we have seen the magnetized bar is riveted to the disk, so that the magnetic declination cannot be set off. In the Lindberg model the bar is pivoted on the disk and held in the proper position by friction, making it easy to set off the variation accurately. So far as we know a floating disk is just as accurate as a needle and it settles more readily when the compass is held in the hands. The outstanding advantage of the disk, however, is that the correct reading is at the line of sight directly in front of the operator, no matter in what direction he is running, and the reading is not likely to be taken at any other point. Also, there can be no confusion as to the East and West markings, because the disk is graduated clockwise and these markings are not reversed.

It may be that readers of this description can point out disadvantages of this type of compass for smoke chasers. The only possible disadvantage we have thought of is the extra weight of the disk and bar, which might cause greater wear on the pivot pin and jewel. This should not be serious, however, if these parts are properly made.

Prevention Yardstick Questioned—The conclusions apparently drawn from the tabulation on pages 318 and 319 of the September number of FIRE CONTROL NOTES are seemingly very misleading. Of the 58 man-caused fires shown for the Cabinet National Forest, 25 are railroad fires. The number of visitors on the Cabinet Forest as reported does not include railroad travel, and since the Cabinet Forest is crossed by two transcontinental lines—the Northern Pacific and the Chicago, Milwaukee & St. Paul—it would seem that if the railroad fires are to be included the number of railroad visitors should also be included. The number of visitors is the number who visit the forest. The number of man-caused fires includes fires not only within the forest, but on lands outside of the forest where fires are handled by the Forest Service through cooperative agreement. An analysis of the 1937 fires, which is very comparable with the 1936 situation, shows that of 121 fires which the Cabinet Forest handled up to and including October 5, 1937, 59 were outside of the forest, and that of the 62 man-caused fires which the Cabinet Forest handled, 43 were outside of the forest. (There were only 5 man-caused fires on National Forest land.) If the conditions on the Cabinet are indicative of the conditions existing on other forests, would it not be well to revise the figures? Certainly, the tabulation does not give a correct picture of the conditions on the Cabinet.—*A. H. Abbott, Forest Supervisor, Cabinet National Forest.*

OREGON CONSTRUCTS A SPECIAL TANK TRUCK

J. W. Ferguson

State Forester, Oregon State Department of Forestry

Experience has demonstrated that there is a definite place in fire protection in Oregon for two types of tank trucks, a large unit constructed on a three-ton chassis and smaller units on the ton-and-a-half chassis.

The principal advantage of the larger truck is in the quantity of supplies and equipment that can be carried. In spite of the size and weight, it can be used on all roads in the State that are built on CCC standards. A single unit of this type was constructed for the Oregon State Department of Forestry this summer, and because of its design, completeness, and new and original features it is thought that a description might be of interest to other protection agencies which might have need of such equipment.

It is a specially designed tank truck constructed on a G. M. C. three-ton chassis with 160-inch wheelbase, dual transmission, giving ten speeds ahead and two reverse, hydraulic booster brakes and dual tires. Maximum width is 7 feet 6 inches. It is a metal panel job throughout, with all tools and equipment fully enclosed in compartments, yet easily and quickly accessible. Compactness and completeness were guiding principles in construction.

The water tank is of 525 gallons capacity, located immediately in the rear of the cab and resting directly on the truck frame in order to lower the center of gravity as much as possible. The power take-off pump is located on the right-hand side just to the rear and below the cab. The pump is of the Edwards gear type, constructed of metal that will withstand salt water.

Pumpers have been called into frequent use in the coastal area of Oregon, where it has been necessary to use the ocean as a source of water supply. A special clutch operated from the cab is provided for engaging the power take-off. The engine speed can then be controlled by a special throttle in the pump compartment. A system of valves makes it possible to pump either directly from a stream or from the tank.

The diameter of the intake is 2 inches. There are two 1½-inch outlets, one at the pump and the other at the right rear of the truck. With the use of Siamese connections, which are a part of the equipment, four streams of water can be thrown at a time. Capacity of the power take-off pump is 140 gallons per minute.

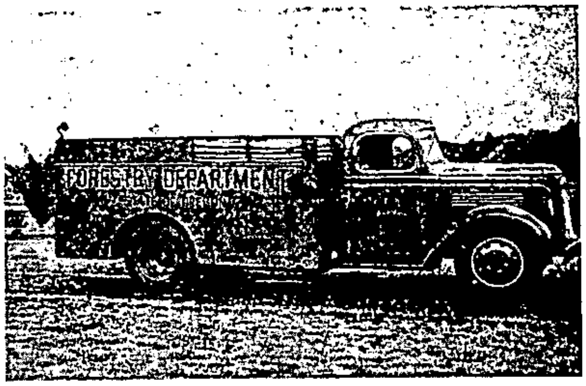
In addition, two Type Y portable Pacific Marine pumpers are carried, each weighing approximately 70 pounds and with a 70-gallon-per-minute capacity. These are in separate compartments on each side near the rear of the truck, mounted on pack boards and resting on sponge rubber cushions to prevent damage through vibration when the truck is moving. There are six 11-foot sections of suction hose—three of 2-inch diameter for the power take-off pump and three of 1½-inch diameter for the portable pumpers. Six tubes were installed in the body of the truck, each carrying a single section of the suction hose. These can be removed through a small 4-by-18-inch door at the left rear end of the truck.

The hose is carried in a special rack constructed on the top of the water tank. It consists of 1,600 feet of 1½-inch rubber-lined cotton hose, 500 feet of the same kind of hose but 1 inch in diameter, and 400 feet of 1½-inch linen hose packed in a sack and attached to a pack board. When the truck cannot be placed within suction hose reach of the water supply, one or both portable pumpers and hose can be carried to the stream and used in filling the tank or pumping direct to the fire. Two 75-gallon capacity relay tanks answer the problem where it is necessary to raise water to an elevation which either taxes the capacity of the pumpers or where back pressure might cause hose to rupture.

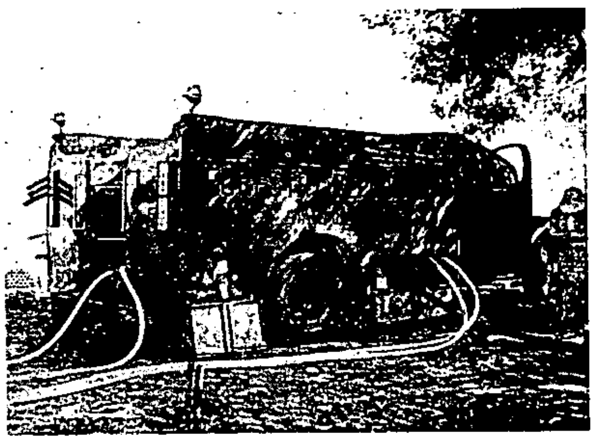
In a compartment in the rear of the truck, similar in construction to that which contains the suction hose but on the opposite side, are three 7-foot falling and two bucking saws, as well as hose connections and pumps for four back-pack pump cans.

There are two upholstered seats in the rear, facing each other, with sufficient room for 8 men. The backs and seat cushions are removable, giving access to the tool compartments. Carried in these are 12 shovels, 12 hazel hoes, 12 axes, falling and bucking wedges, sledges, two dozen electric flashlights for night fire fighting, extra batteries, first aid kit, saw handles, and extra pack boards and pack sacks. Beneath the bed at the rear is an auxiliary gas tank of 25-gallon capacity with gas already mixed with oil and ready for the pumpers, and a convenient valve for filling portable gas cans. Two additional portable gas cans are carried, also filled with gas, for the pumpers. These, together with four backpack pump cans, occupy a compartment on the left front side.

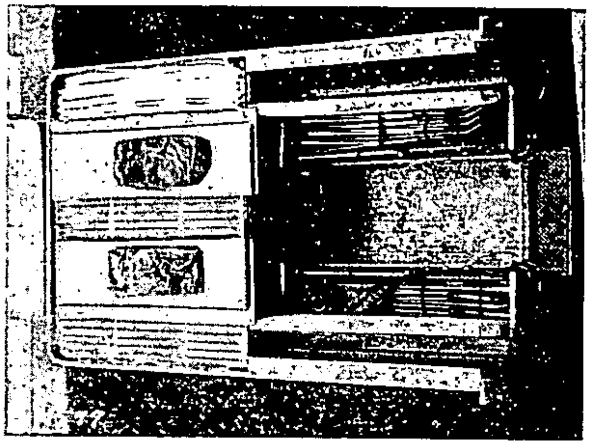
With the truck as now equipped it will provide hand tools and equipment for a crew of at least 50 men. However, in case of emergency it would be possible to carry at least double the number of hand tools in the truck bed between the two rear seats. A thousand-mile trip over various roads throughout the State, together with severe tests of the pumping equipment, has demonstrated that the unit is extremely practical. It is powerful and speedy, and represents one of the most important additions yet made in the State's protective equipment.



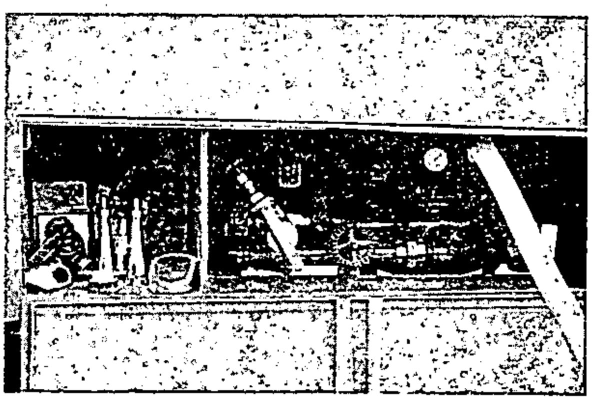
Tank truck recently placed in commission by Oregon State Department of Forestry



Side doors open, showing power take-off pump with hose connected, including suction and Siamese outlets at side and rear. Also Pacific Marine portable pumper in place. Small doors at rear for access to suction hose and saw compartments.



View from above, with seat cushions removed, showing tool compartments. Hose rack in front, with water tank underneath.



Close up of power take-off and pump

THE HANDLING OF THE BLACKWATER FIRE

David P. Godwin

Division of Fire Control, Washington

As soon as the news of the Blackwater Fire on the Shoshone National Forest was received in Washington, action was taken to investigate the circumstances of the tragedy. This article is a transcript of that portion of the investigative report of David P. Godwin dealing mainly with the organization and the attack.

1. *The Cause*—An electrical storm had occurred in the general vicinity of Blackwater Creek on Wednesday, August 18. The fire when seen from the air by Assistant Supervisor Krueger on August 20 appeared to be only about two acres in extent, and was in the creek bottom at a point indicated on the map.

A careful resurvey of the area on August 28 resulted in the discovery of the tree which had been struck. It was an alpine fir (Abies lasiocarpa) about 16 inches DBH, located on a low bench about 100 feet west of main Blackwater Creek. The tree was split to the ground and several large split slabs were scattered about the base. The ground litter at the base of the tree had evidently ignited at once. In the immediate vicinity the forest was fairly open, with little ground litter. The fire had evidently worked slowly uphill to the west and then with a change of the wind came down into the creek bottom, and later—on Friday—had started across the bottom and uphill in an easterly direction.

There was an unused trail (little more than a game trail) along the creek, but the first man to arrive found no indications of recent human use. There is no evidence whatever to indicate that the fire may have been man-caused.

2. *Reporting and Travel Time*—As shown in the chronological outline, the location of the fire was reported to District Ranger Fifield at the Wapiti Ranger Station at 3:45 p. m. Friday, August 20. At 3:52 p. m. he left for the fire, after having made his first call for the available men (20) then at the Wapiti CCC camp. En route he stopped at Blackwater Lodge, at the mouth of Blackwater Creek, and at 4:05 p. m. telephoned the Wapiti CCC camp for 50 more men (or all then available). He arrived at the fire at 5:10 p. m. This one hour and eighteen minutes is good travel time, considering the terrain, the stops made, and the fact that Fifield, being new in this district, was not thoroughly familiar with the territory. He had traveled 8 miles by highway, 3 miles by unused logging road, and 2 miles by unused trail.

The first crew (7 men and Foreman Bryan Sullivan of the Wapiti CCC camp) arrived at the fire at 5:45 p. m. The second crew of 20 men from the Wapiti CCC camp arrived at 5:50 p. m. This latter crew had traveled 6 miles by highway, 3 miles by unused logging road, and 2 miles by unused trail.

By 8:00 p. m., Fifield had 58 enrollees and 7 overhead. The BPR camp, located about 3 miles up the highway from Blackwater Lodge, had been called upon at 10:30 p. m. to send a crew, but because none of the men were in camp it was not possible to get in touch with them until morning, and the crew of 9 men did not arrive at the fire until 10:00 a. m. Saturday, August 21.

The travel time on the whole was fair. With some crews it was very good. In the many later arrivals of CCC crews after Saturday noon the travel time was good. Consideration must be given to the fact that many of these movements were at night and over long distances, with need for stops. (See later discussion of travel time of the Tensleep crew.) The following is a statement of crews and their travel time:

Camp	No. Men	Time Called		Trav. Dist.	Time Arrived		
		Date	Hour		Date	Hour	
Wapiti	7	8/20	....	10	8/20	5:45 p.m.	(at fire)
Wapiti	22	8/20	4:05 p.m.	11	8/20	5:50 p.m.	"
Wapiti	15	8/20	4:05 p.m.	11	8/20	6:15 p.m.	"
Wapiti	7	8/20	4:05 p.m.	11	8/20	6:55 p.m.	"
Wapiti	7	8/20	4:05 p.m.	11	8/20	7:50 p.m.	"
Lake	54	8/20	8:00 p.m.	48	8/21	2:30 a.m.	At upper camp
BPR	9	8/20	10:30 p.m.	8	8/21	10:00 a.m.	" " "
Wapiti side camp	12	8/20	4:05 p.m.	76	8/21	10:00 a.m.	" " "
Tensleep	50	8/20	10:50 p.m.	182	8/21	12:15 p.m.	" " "
Deaver	50	8/21	1:30 a.m.	96	8/21	12:30 p.m.	" " "
Basin	51	8/21	9:00 a.m.	106	8/21	5:00 p.m.	" " "
Basin	33	8/21	....	106	8/21	11:00 p.m.	" " "
Worland	60	8/21	1:30 p.m.	137	8/22	1:00 a.m.	" " "
Thermopolis	64	8/21	3:45 p.m.	172	8/22	3:00 a.m.	" " "
Basin	20	8/21	3:45 p.m.	106	8/22	3:00 a.m.	" " "
Worland	24	8/21	3:45 p.m.	137	8/22	6:00 a.m.	" " "

Forest Supervisor Sieker's travel time, as with other unattached overhead, was especially good. He had left Sunlight Ranger Station at 4:30 p. m., had driven 43 miles to Cody and 48 miles from Cody to the lower fire camp, arriving there at about 8:30 p. m.

3. *Attack Plan and Man-Power Estimates*—Before seeing the fire Fifield had ordered all the men (20) he knew were in camp at Wapiti CCC camp. Sizing up the smoke from Blackwater Lodge, and knowing that more men were returning from work to the CCC camp, he phoned again and requested 50 additional men or all that were available. Upon his arrival at the fire and before the arrival of the men, he made what appears

to be a comprehensive reconnaissance. The first 7 men under Foreman Bryan Sullivan had come voluntarily, having seen the smoke from their work, and gone to work on the control line from the point later used as First-Aid Station, before finding Fifield.

When the first crew direct from Wapiti CCC camp arrived, Fifield put them on the control line around the bottom of the fire and up the east and west sides. He then sent a messenger back to Blackwater Lodge to phone for 50 more CCC enrollees.

Sieker, en route to the fire, being apprised of the situation and Fifield's orders for men, stopped at Blackwater Lodge at 8 p. m. and phoned the Park Service CCC Lake camp asking for 50 men (this is the exchange number of men previously agreed upon in cooperative arrangement between the Shoshone National Forest and Yellowstone National Park) to arrive at the fire at 3:30 a. m. Saturday, August 21. (They actually arrived at 2:15 a. m.) Sieker also ordered a pump outfit and an extra supply of beds from Denver (these arrived at the fire at 12:45 p. m. Saturday, August 21).

At 9 p. m. Friday night Sieker met Fifield on the fire line, and after conference and reconnaissance the two officers estimated that the fire, which was then fairly quiet, had covered an area of about 200 acres, and that by the end of the first work period they would have a perimeter of 450 chains. Eighty chains of control line had been constructed at the time of the estimate, and Sieker thought 370 chains could be constructed during the first work period by the 110 men on hand and on the way.

It was Sieker's and Fifield's judgment at that time (9 p. m.) that the fire would not spread appreciably during the night. Events proved they were in error in this calculation of probabilities. Neither Sieker nor Fifield made a written record of this judgment determination.

The area, though quiet, was smoky and difficult to scout. After midnight the wind sprang up, crowning appeared in several places, and the fire began to move out rapidly up the basin of the fork of the Blackwater Creek in a southeasterly direction. Sieker realized the situation had changed sharply, and promptly put in an order through Assistant Supervisor Krueger at Cody (1:30 a. m.) for 50 men from Deaver CCC camp and 50 local men from the town and vicinity of Cody. (The 50 men from Deaver and about 15 men from Cody arrived at the fire at noon Saturday.)

District Ranger Fifield was in charge of the fire. In accordance with the Region 2 fire plan the District Ranger automatically takes charge. Supervisor Sieker rightly respected that arrangement of authority, but because of his greater experience and familiarity with local conditions worked with Fifield in an advisory capacity. Such practice as a general policy should result in the best development of ability and leadership in fire control. Sieker, of course, stood ready to relieve Fifield at any time he thought his management inadequate.

They had scouted the fire properly, had assembled all facts, had appraised the behavior of the fire, and had placed orders for the number of men they thought necessary to corral the fire in the first work period. It was their joint conclusion. It turned out to be wrong, because, in the experience of these men, a strong night wind under these given circumstances was not to be expected or to be included in probabilities.

After consideration of all circumstances, I conclude that Sieker and Fifield, from the factors available to them, took action properly and in sufficient time to insure corralling the fire in the first work period.

A second factor contributing to the subsequent disaster appears in a review of the events of Friday night. At 10:50 p. m., while the fire was still quiet, Sieker was able to get through a call to the Cody office (where the dispatching function was working smoothly) to have a crew of 50 men from Tensleep CCC camp (F-35 on the Bighorn National Forest) report in the morning. He estimated they could arrive at the fire (a distance of 180 miles) at 8 a. m. Saturday. (Because of delay in transmission of the phone call through the towns of Worland and Tensleep and to road stops the men did not reach the fire until about noon Saturday.) Sieker's estimate of travel time for this crew proved to be short by four hours, but he could not have anticipated that his order would be delayed two hours in transmission, and such a truck trip had never been made. It seems reasonable that the crew could have been expected to arrive at the fire by at least 10 a. m. This two hours' lost work had vital effects.

On Saturday morning, because of lack of strength (non-arrival of the Tensleep crew) new line construction on the forward end of the line (eastward from a point near what is now termed Clayton Gulch) had to be abandoned and all men deployed along the constructed control line from that point back to the crest of Trail Ridge and down Trail Ridge, in order to hold what they had and suppress small spot fires.

The plan was to have the Tensleep crew, with Ranger Post, leapfrog the Park crew, under Foreman Wolcott, and the BPR crew, under Foreman Bert Sullivan, and complete construction of the control line from near Clayton Gulch up to the rim rock under Double Mountain at the head of the ridge above Posts Point. If Post's crew had arrived at 10 a. m. they would have had sufficient time to complete the line job well ahead of the 3:30 p. m. gale, which caused the blow-up.

It is purely hypothetical, but a logical speculation, that had this line been completed Post and Clayton and their overhead, freed from the drive of line building, would have had time to consolidate their position; burning out unburned spots southeast and above the line, improving the line itself, mopping up and watching for and treating spot fires far down to the northwest in the location which later developed the spot fire which did the great damage. In spite of such work that might have been done in that lost two hours, it is likely that the 3:30 p. m. wind would have crowned out some of the surface-burnt area above the line and caused abandonment, but routes of egress would have been simpler and well known, and the fatal spot fire below the line, having been discovered and treated, might never have blown up.

4. *Control Line Placement and Construction*—The first crew to arrive (detached crew of 7 men under Foreman Bryan Sullivan) started to work where they hit the fire, a point close to the later established First Aid Station (see map). With good judgment, Sullivan, who had not yet contacted Fifield, commenced line construction up the north flank of the fire, which was then the lee side. The 22-man Wapiti crew, which next arrived, was met by Fifield and put to work along the right flank (southwesterly side of fire). The three Wapiti crews next arriving (15, 7, and 7-man strength, respectively) were well distributed to both flanks, and by 8 p. m. 58 men and 7 overhead were building line in an orderly manner and with good speed.

The first pump arrived and was set up in Blackwater Creek and was operating by midnight. Hose lines from this and the pump received later from Denver were run about 2,000 feet up the north line and about 5,000 feet up the west line. This was most effective in controlling fire spread within the pump's reach.

The 54-man crew from NP-3 of Yellowstone Park arrived at the fire at 2:30 a. m. Saturday after the wind had whipped up the fire. Fifield, realizing that the north side was then the most dangerous, sent the Park crew through Foreman Hill's Wapiti crew, working on the north side, and on up the south slope of Trail Ridge. By daylight this crew had built and was holding line up to the open point on Trail Ridge above where the line later was cut down through the timber on the left of the ridge.

The long west side of the fire had been controlled by the line which had been built to timber line under the cliffs of Coxcomb Mountain. The holding of this control line saved the great body of dense timber covering the main upper basin of Blackwater Creek, which was threatened several times by shifts of wind.

Early Saturday morning the man-power was about evenly distributed to the two main flanks of the fire. Control line construction was good; well trenched to mineral soil and litter, logs and brush removed. In most instances the work was right along the fire. At the top of the line on Trail Ridge, however, where the fire was surface burning down over the ridge to the north, there were some islands unburned.

This control line under the north side of Trail Ridge and along the edge of the surface-burning fire was the tough position of the north sector and was being started Saturday morning by the Park crew when they were pulled off new construction to hold built line down along Trail Ridge. The first reinforcement in the morning was the BPR crew, with Foreman Bert Sullivan in charge, which arrived at the top of the line at about 11 a. m. They were placed ahead of the Park crew, and started in on this control line construction under the ridge. In character and in speed it appears to have been the best line built, yet it was the line which was lost.

Up until the time of the arrival of Ranger Post with his 50-man Tensleep crew, District Ranger Fifield had had charge of the whole fire. At 1:30 p. m., Supervisor Sieker, at Upper Camp, gave instructions to Ranger Clayton, who had just arrived, to take charge of the advanced sector extending east and north from Trail Ridge, leaving Fifield in charge of the rest of the line from there down to the bottom and all around the west and south sides. Ranger Post, who was to take the forward end of Clayton's sector, was sent up Trail Ridge with Foremen Saban and Tyrrell and the Tensleep crew, with instructions to relieve and send into camp the men of the Wapiti crew, under Foreman Hill, and to leave the Park crew of 25 men, under Foreman Wolcott, in place to hold their line. Post was to pass on beyond the BPR crew, who were then building line at the head, and carry forward the line north and east.

Sieker and Fifield had been on the job for almost 24 hours, so at 3:30 p. m., as previously planned, Sieker instructed Assistant Supervisor Krueger (who had just arrived) to take charge of all line from the west end of Clayton's sector, down Trail Ridge and all around the bottom and up the west and south sides, thus relieving Fifield. However, the blow-up came at this time, and Fifield and Sieker remained in charge of the whole fire. Before these two men eventually left the job they had been up about 64 hours.

Ranger Post had arrived at the Lower Camp at 9 a. m. Saturday, it being understood that he would take charge of the Tensleep crew, which at that time was on the road and expected to arrive about noon. In his talk with Krueger in Cody early in the morning it had been agreed between them that it would be better for him to await the crew at Lower Camp rather than go ahead alone up to the head of the line.

The control lines, on the whole, were located to the best advantage and were well cleared and trenched. Viewed in aftermath, it might be considered that the one exception to uniformly wise line placement was the fatal subsector extending east and north from the high point on Trail Ridge.

During Friday night and early Saturday morning the main fire slopped over through the saddle in the ridge above the highest point on the ridge line. The fire slowly surface-burned down the north slope of the ridge in dense timber. This situation prompted the decision to put through a control line under the fire and along the burning edge. The first work on this line was done by the Park crew.

About 11 a. m. the BPR crew, Foreman Bert Sullivan in charge, passed through the Park crew and proceeded to continue this line, building to the east. The fire made a short run down a side ridge, but the BPR crew swung the line down under it and had it extended about to the sharp ravine in which Clayton and 6 men were later trapped, when Post's crew came through them. In view of the possibility of spots developing below (which they did), and the approach of mid-afternoon, with its to-be-expected winds, the pushing through of a line on this slope by the Tensleep and BPR crews appeared in first judgment to have been a dangerous undertaking. It was, however, the obvious tactics to be pursued by men directing fire fighting to hold the area and save timber. These officers and foremen are trained in the principle of "the fire must be corralled." They did not consider the situation dangerous, and certainly did not consider the move rash. It was the logical way to stop the fire and save the whole basin to the north of Trail Ridge. They did not know there was a sleeping spot "down in the hole," nor did they know the relative humidity registered the extreme low of 6 per cent at the Wapiti Camp at 1 p. m.

Had they known these things, and anticipated an afternoon wind, their action probably would have been different. But, weighing the known factors, Post and Clayton thought the job a normal undertaking and one not involving more than ordinary risk to men. An alternate to this would have meant abandonment of this sector, pulling all men out to Trail Ridge. If they had done this, the only logical next step would have been to move the crews, with a loss of several hours, up Trail Ridge, around the base of the cliffs of Double Mountain and down Posts Ridge (later named) or the ridge southwest of Logging Gulch and establish new lines. With the later crowning and running of the fire, these positions may have proved just as hazardous as the position they did occupy. With the knowledge they had, and in view of their fire-fighting experience, I feel that their judgment and decision were right.

5. *Circumstances of the Blow-Up and the Tragedy*—The statement of A. A. Brown, presenting an analysis and reconstructed picture of the behavior of the blow-up fire of Saturday afternoon and the tragedy in its path, follows this article. The subject, during the review, was presented by Brown and came under full discussion of the investigating group. The Forest and Regional officers and I agree with the analysis and concur in the conclusion set forth in this written statement.

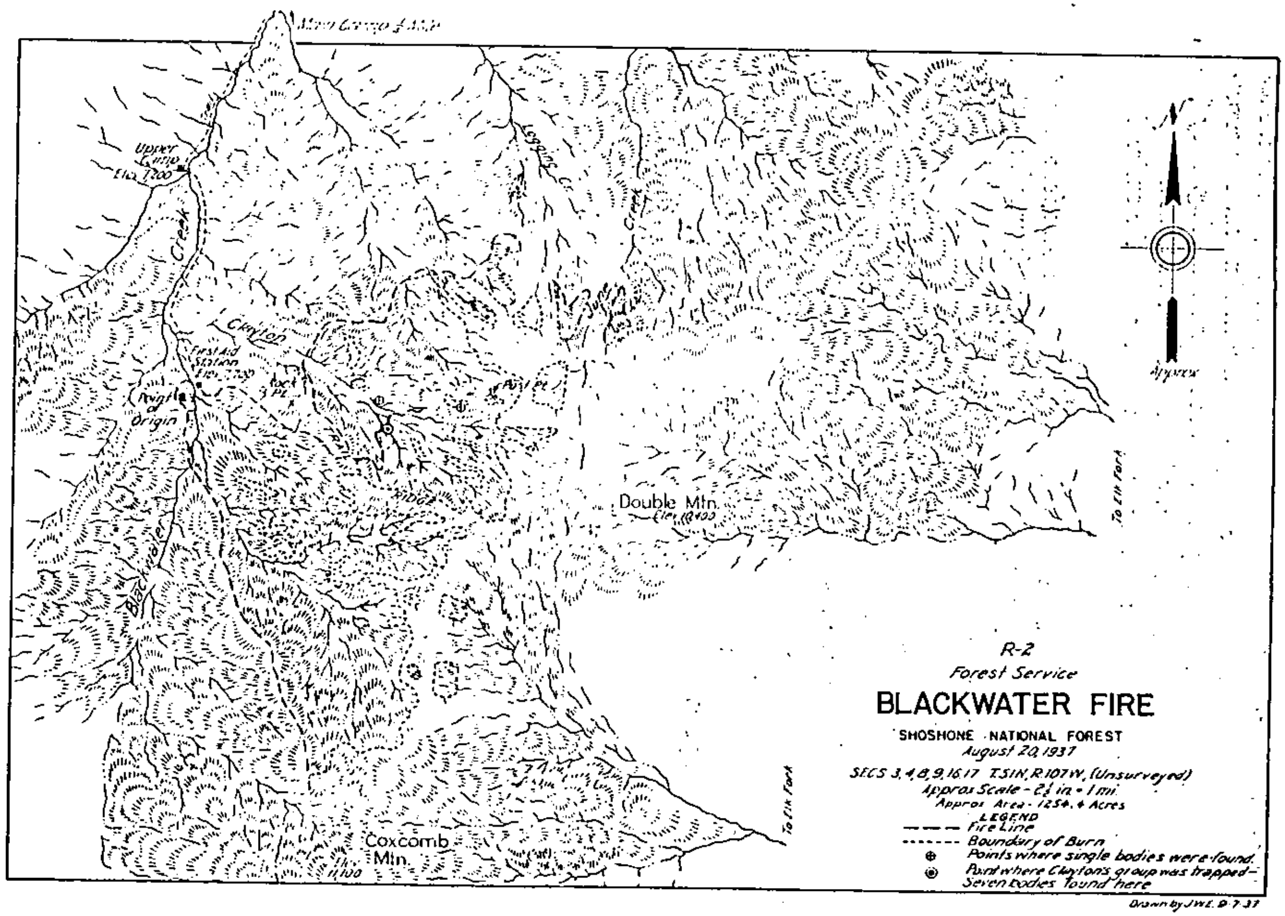
A point not mentioned by Brown is that Assistant Supervisor Krueger, who was directly over the fire area at approximately 12:40 p. m. Saturday, saw two stringers of smoke from spot fires below the newly constructed line (running east and north from Trail Ridge). These, however Krueger reports, were close to the line, and have since been identified as spot fires being worked on and not the spot fire down "in the hole," which at about 3:30 p. m. blew up and became the greatest factor contributing to the disaster. That critical spot fire was evidently not throwing smoke at 12:40, for it was not observed by Krueger.

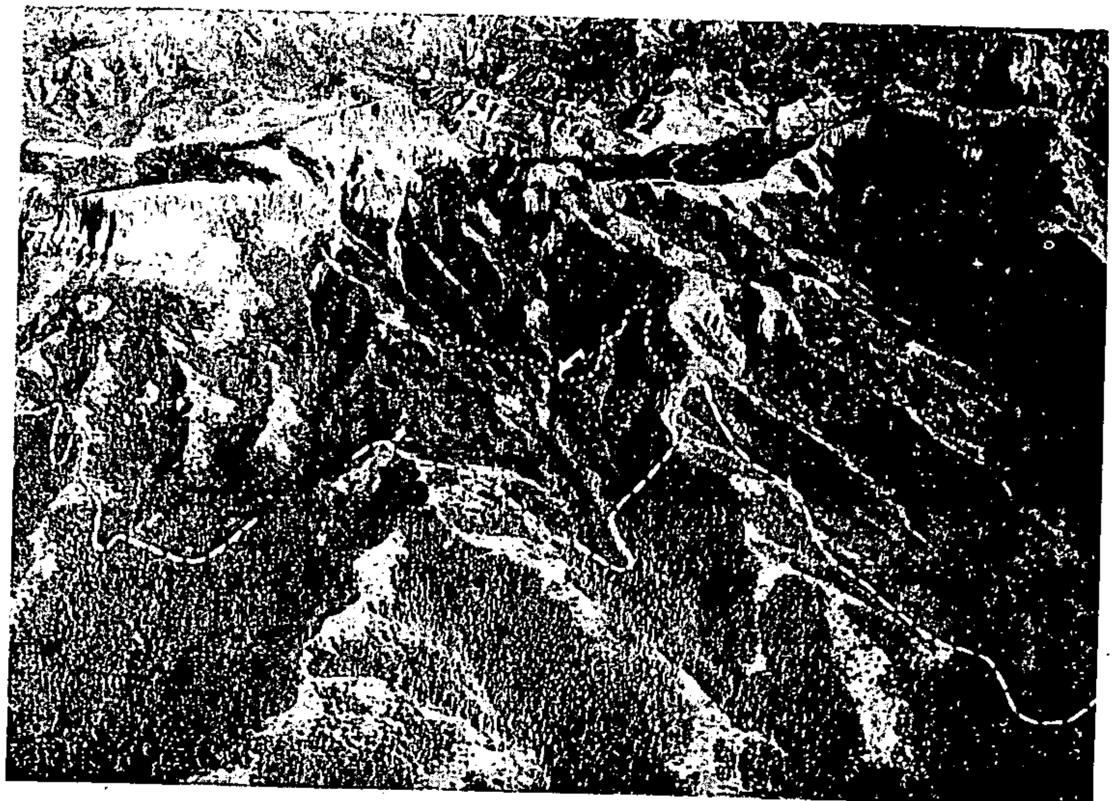
6. *Summary*—After careful review of all the circumstances and acts I find no reason for criticism or organizational change. In reaching this conclusion, full weight and consideration were given to certain things which might have been done differently and better: the communication system was not of the best; the local cooperators failed to turn out as per fire plan; the probability of a night wind Friday night was not a part of the calculation; failure of the Tensleep crew to arrive earlier on Saturday probably contributed to the disaster; there was a lack of written messages and time notations; some unburned fuel was left above the line.

On the other hand, it is clearly evident that this fire was handled in a manner reflecting sound experience and knowledge. The placement and construction of control lines was well done, in spite of rough terrain and bad fuel. The large body of timber on the main basin of Blackwater Creek was saved by the handling of the west line. The camp management and feeding was efficient. Tools and equipment were sufficient and in proper condition. The enrollees were at all times under capable and watchful supervision (overhead was in proportion of 1 to 10). The dispatching job and the assembly of suppression forces were adequate and well handled. The supervising personnel worked smoothly and without misunderstanding. They followed the approved Forest Service practices of fire control. Continuous hard work and intelligent action and courage show up through the entire four-day period.

Nothing can compensate for the distressing loss of human life, although there is some comfort in the knowledge that the leadership was intelligent and protective of the men.

Regrettable as it is, it must be recognized that in man's control of forest fires some accidents will occur—just as in city fire protection—without fault or failure on the part of anyone. Here was brought about a peculiar combination of circumstances rare in forest-fire history. It is reassuring to know that such occurrences are infrequent. Not since 1910 have so many lives been lost on a single national forest fire, and fatalities from burning are very uncommon, although probably more than 100,000 men fight fires in the average year.


R-2
Forest Service
BLACKWATER FIRE
SHOSHONE NATIONAL FOREST
August 20, 1937
SECS 3,4,8,9,16,17 T.51N, R.107W, (Unsurveyed)
Approx Scale - 2¼ in = 1 mi.
Approx Area - 1254.4 Acres
LEGEND
Fire Line
Boundary of Burn
Points where single bodies were found.
Point where Clayton's group was trapped - Seven bodies found here
Drawn by J.W.L. 9-7-37
Upper Camp
Creek
Clayton
First Aid Station
Point of Origin
Blackwater
Double Mtn.
Coxcomb Mtn.
Legging Cr.
To Elk Fork



Aerial view of Blackwater burn looking southeast directly up the head of Clayton Creek. Dash line indicates lower boundaries of fire. Dotted line indicates the lost control line. Right-hand arrow shows gulch where Ranger Clayton and seven men were trapped. Left-hand arrow shows open point on ridge where Ranger Post took refuge with his crew.

THE FACTORS AND CIRCUMSTANCES THAT LED TO THE BLACKWATER FIRE TRAGEDY

A. A. BROWN

Fire Control, Region 2

Included as a vital part of the full report on the Blackwater Fire was the report made by A. A. Brown after an exhaustive study of the fire behavior and the critical circumstances which converged to bring about the tragedy. Mr. Brown had been only recently transferred to Region 2 to head the fire rontrol work of that Region, and he brought to the tasks involved in this disaster the sound knowledge and discernment springing from long and successful fire experience.

While no proof is available, the nature and circumstances of the blow-up on August 21 seem to indicate that an undiscovered spot fire, probably from the night before, to the north of Clayton Gulch and over the small, sharp ridge in Clayton Creek (one-half mile west and north of the point where the Clayton group was later found), was the first critical factor in making the trap in which the men were caught and burned to death on that day. Apparently this spot fire at first spread up the slope immediately above to the northeast. This is clearly indicated by the note Ranger Clayton sent to Ranger Post at the time the spot fire spread conspicuously just prior to the blow-up.

The second critical circumstance was the fact that the timber above the newly constructed line had not crowned out except for a small fringe along the south edge. The third critical circumstance was the fact that "spotting" from the fire of the previous day had given a ragged edge to the burning area on the steep downhill side, with small spots below the general front. As a result the fire fighters found it expedient to connect the fire line below the hottest spots, leaving considerable unburned surface fuel inside the line at the lowest point.

The fourth critical element was the nature of the forest fuel in this drainage. It consisted of a very dense stagnated stand of Douglas fir with a varying mixture—5 to 15 per cent—of spruce and of alpine fir. A dense overhead canopy existed, with dead branches nearly to the ground, with many small, brushy, dead or nearly dead suppressed trees as an understory, a considerable volume of sound dead branches, logs and suppressed trees on the ground, and with varying amounts of moss throughout the canopy and on all the dead branches. In addition, slopes of 20 to 60 per cent prevailed.

These four factors set the stage for what happened.

The relative humidity at 1 p. m. on August 21 was 6 per cent, with a temperature of 90 degrees at the fire danger station at the Wapiti CCC camp, two and one-half miles away at 2,000 feet lower elevation. At approximately 3:30 p. m., with these critical circumstances prevailing, a strong gusty wind of apparently at least 30 miles' velocity per hour came up from the southwest. About 3:45 p. m. it swerved and became a west wind. (These times are based on the circumstantial evidence of other events of the fire.)

The duration of this strong velocity is uncertain because of the strong convectional winds set up almost at once by the crowning. It is reasonable to suppose that the change in direction may have been largely a convectional effect. At the start, timber began to crown above the line and the whole fire there began to pick up in intensity and to throw new spots below the line, as might be expected. Possibly this exerted a strong convectional pull on the spot fire below, which had also begun to crown.

At any rate, the course of the drive from the spot fire changed to the east and started directly up the drainage. The two crown fires then rapidly closed together with the cyclonic effect of such a circumstance, which reached its climax at 4:20 p. m. As a result, the major portion of the head of the Clayton Creek drainage from the spot fire up to Double Mountain was swept clean in a final crown fire conflagration which was completed by approximately 5 p. m.

In this conflagration 9 deaths occurred directly. Six additional men were so badly burned that death ensued, and 36 additional men suffered injuries from which they are recovering.

Just before the crowning started, the distribution of men on the newly constructed line in Clayton Creek had been as follows: Five men of the National Park Service crew on mop-up were operating as far as the first small park, about 5 chains northeast of the ridge. Beyond them for 30 chains were 6 men of the BPR crew, who had been actively pushing the new line construction from this point on, and who had got as far as Clayton Gulch, plus a few men who had been dropped off from Post's crew. Beyond them were Ranger Post, with Foremen Tyrrell and Saban and sub-foreman Hale, with about 40 men who had taken up the new line at Clayton Gulch and had completed 16 chains at the time the blow-up occurred.

Clayton, who had been placed in charge as sector boss of the new construction, was following the fresh crew in and checking up on conditions as he went. Apparently he was checking particularly on spot fires. The BPR crew were giving most of their attention to spot fires at two points below the 30 chains of line they had constructed. They were about 20 chains in from Trail Ridge, except for Pierce, one of their members who had been left alone on hot line at a point about 10 chains in, where several logs were on fire close to the fire trench. Two men were left to help him as Post's crew came past and about 6 men were left with Saban and Clayton to work on spot fires.

By the time this distribution was completed, about 3:45 p. m., Post, Clayton, and Fifield, probably simultaneously, saw evidence of an uncontrolled spot fire. Fifield, according to his statement, was on the rock point of Trail Ridge at the time and thought at first that it was the spot near the bottom of the first gulch which had previously been found and trenched, but discovered instead that it was in line with it, but over the small ridge just to the north. He at once gave thought to Wolcott's crew, who were in this vicinity, but found them coming out on account of the crowning there. Wolcott immediately went on up Trail Ridge and also called out the men from the fire trail north of Trail Ridge. Pierce, who had been near the highest point of the fire trail before it dipped down into Clayton Gulch, had already come out to the first small park with the two CCC boys helping him because of a flash of crowning just below him, which apparently crossed the fire line but died down again at the little park. He attempted to get the attention of the rest of the BPR crew, but, receiving no answer, decided they were withdrawing the other way.

About 6 other CCC boys were also assembled at the park, and all came out together at Wolcott's alarm call. The heavy crowning apparently occurred shortly afterward (about 4 p. m.). Post's attention was attracted to the spot fire when it started crowning toward the northeast up the slope on the north side of Clayton Creek. His first thought was to take his crew to it, but the wind changed and the fire started up the gulch before he could take any action to that end. Accordingly he started moving his crew from its path as best he could, as described in his statement.

Clayton's movements are not so clear in detail. It is evident from the note he dispatched to Post that the spot fire had attracted his attention, apparenly from on the spur ridge just south of the gulch, where he was later trapped. Up to the time this fire started directly up the gulch it was a threat to the line above which must be stopped, but probably did not appear to be dangerous to life. Clayton saw it was the focal point if the line were to be held, and that more men than the 7 with him would be required.

It does not seem likely that he waited on the ridge above Clayton Gulch the 20 minutes or more that seems to have elapsed from the first active spreading of the spot fire below until the general blow-up occurred. Probably he started down toward it, either with his group or alone. If alone, he probably left instructions for his group to await his investigation of potentialities below. Or, if he took his group, he probably left one or more men at the spring in the gulch to await reinforcements from Post. In either case, the natural route of travel toward the spot fire would be down the gulch toward it. (Never travel down hill!)

Once off the ridge the full potentialities of the fire below would not have been immediately as evident to him as it was to Post above. Presumably, as soon as he saw what was about to happen, he turned back to get the men at the spring. In doing so he had to go back up the slope ahead of the fire and probably got to his men just at the time that every avenue of escape was cut off. Had the fire been going across topography the bare gulch might have served satisfactorily as a refuge. With the direction of its path directly up the gulch, it probably acted as a furnace draft and became a death trap.

In conclusion, the reconstructed tragedy depended on each of the four factors first discussed which contributed to the behavior of the fire, plus the distribution and movement of the men at the time. The high wind and burning conditions alone, without the spot fire, would have created a dangerous situation, and would have no doubt forced abandonment of the newly constructed fire line, but without loss of life, since distances to safety were not great. Exactly the same strategy employed would likely have succeeded without incident a few hours earlier, or perhaps even at that time of day if no sudden change in wind velocity or direction had occurred.

Had the spot fire not been in line with one already controlled, or had not been hidden by the sharp little ridge in the bottom of Clayton Creek, it would have had earlier attention from the Park crew from Trail Ridge, and again the situation would have been changed.

More time on the part of either Clayton or Post to fully scout out the potentialities of the fire ahead of the crews might have prevented the tragedy.

Earlier arrival of the new crew, even by as little as a half hour, would have resulted in completing the new line and would have concentrated the attention of all supervising officers and man-power on all threats to holding it. This would have resulted in a different distribution of the crews and probably slight danger. Many other premises may also be drawn, but the matter of timing of action of the fire vs. movement of men gave the distinctive and fatal combination.

C. C. C. DETERMINATION

John Sieker

Supervisor, Shoshone National Forest

One bright memory in the midst of all the tragedy surrounding the Blackwater Fire was the response of the CCC crews the morning following the blow-up.

Naturally, all fire suppression work had ceased during the night. All available foremen and men were on searching parties looking for injured men. At daylight a 150-man crew was again out searching for any that might have been missed during the night, and arranging for removal of the dead. But tragedy or not, there was still 1,200 acres of fire running around loose, and the humidity was below 10. Scouting and line construction had to be done, and there were only tired, depressed men left to do it.

The CCC men rose to the occasion like veterans, and at daylight three crews were on the fire line carrying on—determined to whip the fire that had beaten them so terribly the afternoon before. These boys put through difficult line that day and held it through a very critical afternoon. Most of them had seen horrible burns the night before, and many saw corpses packed out during the day, but they did not let that deter them in their attack on a stubborn fire.

The CCC responded to an emergency in a very noble and courageous manner, and the Shoshone and the entire Forest Service appreciate it.

CALCIUM CHLORIDE AS A FIRE RETARDANT IN GROUND LITTER

Morris Fram

Junior Engineer, Region 5

Calcium chloride is so strongly hygroscopic that it will often go into solution with moisture absorbed from the air. This property is sometimes used to keep dirt roads wetted down permanently, and it seems possible to wet down beds of ground litter effectively by spreading a line of these crystals in advance of an approching ground fire. Though these properties of calcium chloride are known, the time required for the salt to go into an effective solution with moisture taken from the air and wet down a bed of litter or brush under summer conditions and its practicability in fire fighting remain to be determined.

Some preliminary tests of this form of wetting down ground litter were made at Cuyama Ranger Station, Los Padres National Forest, on May 13, 1937, and it was found that if allowed to act overnight the application was effective, but that it was not effective if allowed to stand for only a short time during the heat of a dry day. In conducting these tests, usual ground conditions under pine trees were duplicated as far as possible. The litter was carefully laid about two inches deep, the calcium chloride sifted over it uniformly, and the plot allowed to stand until it was ignited.

To get a definite comparison between the burning action of the litter when treated and untreated, each plot had next to it a similar but untreated plot which was ignited at the same time, and which, therefore, burned under the same conditions. For economy in building plots, the untreated control was made with a treated one on each side, thus acting as a comparison for two tests run at once. The three were in line, ignited together, and gave data for two tests at once. To restrict the size of the plot and to achieve uniformity, they were built inside a standard framework of pipe four feet square and ignition was made by pouring a thin line of gasoline to the windward side of each and touching it off.

Because certain applications of the salt definitely retarded the fire by reducing but not stopping its rate of spread, the effect of the application was judged by the rate of spread of the fire over the treated in comparison with the untreated plot. If the untreated plot burned over its entire area while the adjacent plot, with the calcium chloride, progressed only 40 per cent of its area, it was said that the rate of spread of the fire was reduced to 40 per cent. With the heavier applications, the treated area would support no flame whatever; therefore, it was said that the rate of spread was reduced to 0 per cent. In the very light applications where the salt had no measurable effect the rate of spread of the treated fire was said to be 100 per cent. The values were judged by eye as nearly as possible, and are shown in the following table and graph.

In the first series of tests run the technical grade salt containing 30 per cent moisture was allowed to remain on the bed of litter for an overnight period. On the following morning, May 13, 1937, at 8 a. m., the test was started. The weather was clear, temperature 79 degrees F., relative humidity 43 per cent, with practically no breeze. The following is a summary of the overnight application tests:

Quantity CaCl Applied		Fire Reduced to (Speed) Per Cent	Remarks
Total Pounds	Pounds Per Sq. Ft.		
¼	0.016	100 (no effect)	
½	.032	100	
1	.063	100	
2	.125	100	
4	.250	40	Did not burn in the center at all
6	.375	30	Did not burn in the center at all
8	.500	0 (stopped fire)	Burned only at outer edges
10	.625	0 (stopped fire)	Burned only at outer edges

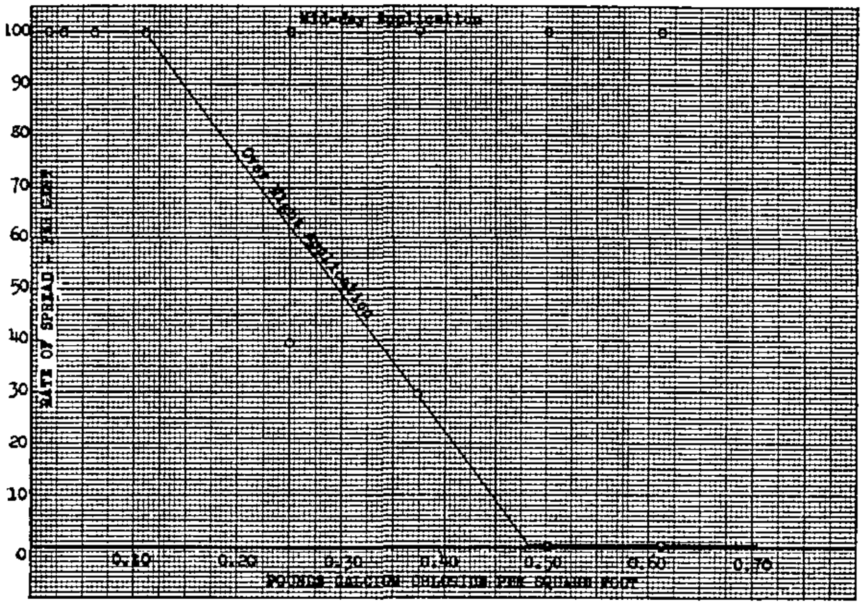
The same results are illustrated in the graph on the following page. The litter was damp where the calcium chloride crystals had been in contact with it, but in the case of the heavier applications the calcium chloride seemed to form a crust with the moisture it absorbed, which protected the crystals from going further into solution and also seemed to be effective in protecting the fuel from the fire.

Another similar series of tests were run during the heat of the day to determine if an application would be effective if allowed to stand during the hotter and drier hours. The result in this case was entirely negative. On May 13, 1937, application of the salt was made on litter beds at 11:30 a. m., when the temperature rose to 87 degrees F. and the relative humidity was 29 per cent. It was allowed to stand 4¼ hours, or until 3:45 p. m., when the temperature was 91 degrees F., relative humidity 27 per cent, weather clear and breezy. At the time it was ignited, no sign of the salt going into solution could be observed, and the only effect, if any, seemed to be the smothering effect similar to an equal amount of dirt. A study of graphs, marked Fig. 1, 3, and 4, included in this report, indicates that the salt was theoretically at the point of going into solution under the mid-day conditions, but the dampening action may have been taking place too

FIRE RETARDENT EFFECT OF CALCIUM CHLORIDE ON PINE LITTER

Litter 2" deep
Calcium Chloride contained 30% moisture
Cuyama Ranger Station
May 13, 1937

F. W. Funke, Project Leader
J. Allen
M. Fram



slowly. This is because, in general, the conditions during midday are such that even if the salt would go into solution, the very low difference in vapor pressures between the solution and the air would require the action to take place very slowly. This can be noted from the graph of vapor pressures, as illustrated in Fig. 4. On the other hand, once the fuel is dampened with a solution, either applied as such or applied as a salt and allowed to go into solution with moisture taken from the air, drying out, due either to the weather conditions met during a hot, dry day, or to an approaching fire, would be very much slower than drying out of plain water.

No other claims can be made for calcium chloride in fire fighting, but from its property to take moisture from the air, moisten fuel, and hold the moisture under dry conditions, this salt and its solution seem to show some promise if applied under certain conditions. What these conditions are, what exact quantities are required, method of application, and whether the whole thing is worth while must be determined by further tests under conditions found in the field on going fires.

It seems entirely probable that on large fires where man-power is insufficient to build control lines, the pre-treatment of selected areas with calcium chloride well in advance of the fire will create an effective barrier which will definitely retard the advance of the fire. Under favorable conditions it will check the spread of ground fires.

It should be pointed out that there is a very definite relation between relative humidity and the amount of moisture which will be absorbed by the chloride. At first glance it might not seem worth while to consider an agent which is active only when rate of spread or inflammability is low, but there are many instances on every large fire when the humidity is sufficiently high to make a chemical of this type effective. Once having absorbed enough moisture to go into solution, the liquid will maintain a reasonably moist condition in litter under quite high temperatures and low humidity conditions.

The information which is here passed on to the field is an abstract of data developed as an incident to the Aerial Fire Control Project work in the California Region. There is little which is conclusive, but there is a suggestion which it is felt will have application once the technique has been developed. It is hoped that the data will form the basis for further experimentation by interested agencies to determine the practicability of such applications.

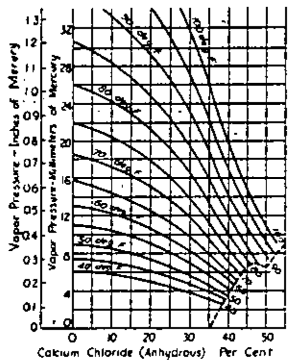


FIG. 1. VAPOR PRESSURE OF CALCIUM CHLORIDE SOLUTIONS

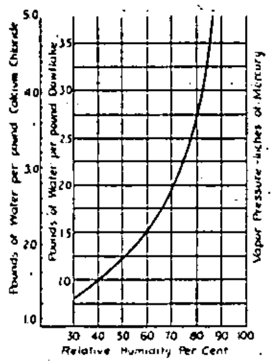


FIG. 2. WATER CONTENT OF CALCIUM CHLORIDE SOLUTIONS FOR VARYING RELATIVE HUMIDITIES

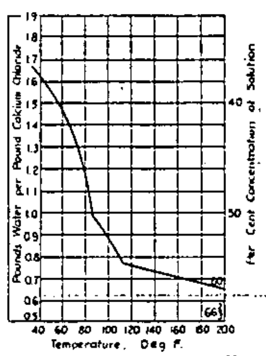


FIG 3. CONCENTRATION OF SATURATED CALCIUM CHLORIDE SOLUTIONS FOR VARYING TEMPERATURES.

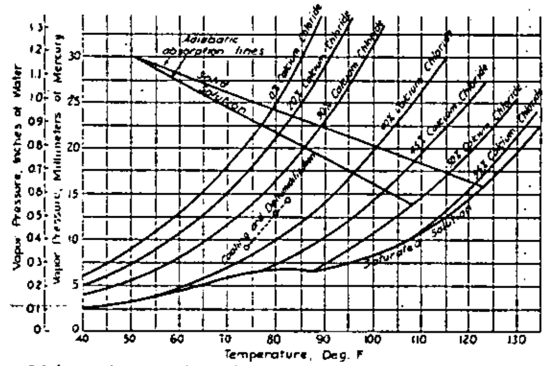


FIG 4. VAPOR PRESSURE OF CALCIUM CHLORIDE FOR DIFFERENT TEMPERATURES

EXPENDITURES PER ACRE FOR PREVENTION AND PRESUPPRESSION

National Forest and Private Land Inside Boundaries

(Protection Boundaries R-7, 8 and 9)

DIVISION OF FIRE CONTROL

Washington

The cost per acre of fire control includes (1) direct expenditures and (2) cost adjustments. Cost adjustments include maintenance and depreciation on fire control improvements; a proper share of maintenance and depreciation of improvements used by other activities as well as fire control; depreciation on fire control equipment, and the value of CCC and similar labor where such expenses are not paid from allotments to the Forest Service. Cost adjustments for FY 1937 (ending June 30, 1937) are not yet available. In the following table expenditures only are compared for fiscal years 1936 and 1937. The 1936 figures are the same as on page 224, April FIRE CONTROL NOTES, except that a correction in area protected that year in Region 9 has changed the figures for that Region. Note that suppression expenditures are omitted from the table.

REGION	PREVENTION		PRESUPPRESSION		TOTAL	
	F. Y. 1936	F. Y. 1937	F. Y. 1936	F. Y. 1937	F. Y. 1936	F. Y. 1937
1	.004	.0026	.026	.0365	.030	.0391
5	.010	.0098	.024	.0375	.034	.0473
6	.003	.0042	.021	.0294	.024	.0336
2	.001	.0008	.002	.0043	.003	.0051
3	.000	.0003	.004	.0070	.004	.0073
4	.000	.0008	.006	.0111	.006	.0119
7	.009	.0129	.021	.0380	.030	.0509
8	.006	.0105	.023	.0222	.029	.0327
9	.007	.0057	.028	.0511	.035	.0568

RULE OF THUMB FOR DETERMINING RATE OF SPREAD

J. A. MITCHELL

Lake States Experiment Station

To determine the approximate rate of spread of a fire in terms of perimeter increase, multiply the rate at which the head of the fire is advancing by ***three.***

Example: If the head of a fire is advancing at the rate of 5 chains per hour (5.5 feet per min.), the rate of spread is approximately 3 times 5 or 15 chains per hour.

The same result may be secured by: (1) *Multiplying* the number of feet the head of a fire advances in 10 minutes by *.27*; or (2) *Dividing 180* by the number of minutes required for the head of a fire to advance 1 chain.

The above rules are based on the mathematical relationship of the diameter of circles to their perimeter ($d\pi = p$) and the fact that fires spread primarily in one direction. Three is used instead of π or 3.1416 to simplify computation and because fires tend to be oval or egg-shaped rather than circular after the first few minutes, thus reducing the ratio between perimeter and diameter as measured on the long axis. If fires spread equally in all directions, the relationship of advance of front to increase in perimeter would be expressed by 2π or 6.2432. This condition, however, rarely prevails, since advance of front against the wind is usually negligible. On the other hand, the ratio of advance of head to perimeter increase in the case of long, narrow fires tends to approach 2.

While the rule of three given above for computing rate of spread is obviously not precise, it offers a ready means of determining on the ground the approximate rate at which line must be constructed in order to bring a fire under control.

The following table shows, for various rates of advance of front, the corresponding rate of spread or perimeter increase in chains per hour as determined by the rule in question:

Rate of Spread (Perimeter Increase) in Chains per Hour in Relation to Advance of Front

Advance of Front Feet in 10 Minutes	Advance in Front Minutes per Chain	Rate of Spread Chains per Hour*	Rate of Spread Chains per Hour*
5	1	1	180
10	2	3	90
15	3	4	60
20	4	5	45
25	5	7	36
30	6	8	30
35	7	10	26
40	8	11	23
45	9	12	20
50	10	14	18
55	11	15	16
60	12	16	15
65	13	18	14
70	14	19	13
75	15	20	12
80	16	22	11
85	17	23	11
90	18	25	10
95	19	26	9
100	20	27	6

*Rounded off to nearest chain.

Locating Radio Sets Visually—As the "S" sets are mainly used intervisibly, there are times when the exact location of one or both of the two sets needs to be known. This is especially true in the search for small fires in broken country where the lookout stations may direct the searching party, provided their exact locations are known to the observer. The Trinity Forest, after utilizing fruit tins, eyeglasses, white shirts and other paraphernalia of the average fire crew, solved the problem by inserting a metal trench mirror in the cover of the sets. The mirror is recessed flush in the wood and has a ¼-inch hole bored in the center and through the wood cover. In use, a spot is picked out where the station to be flashed can be seen. Then a twig is found in line with the station and the mirror. By flashing on the twig and keeping the shadow on the twig's end, the other station can be lined up in the same manner as used in the heliograph method. Use of the mirror does away to a great extent with the necessity for radio standby on lookouts in order to contact traveling officers who flash in the observers as desired. Obviously, an extra mirror to be used when flashing in the direction of the sun's rays is desirable.—*George Buxton, Administrative Assistant, Trinity National Forest.*

FUEL CONTAINER FOR PORTABLE PUMPERS

K. M. MacDonald

Fire Assistant, Nicolet National Forest

Two fuel containers of the type shown below were constructed and put into use three years ago on the Argonne District of the Nicolet. They have been used continuously since that time and as yet show no appreciable signs of wear or damage.

These containers were constructed because no can or container commercially available met the need for a strong, leak-proof fuel container of a shape and size suitable for use in connection with portable pumpers.

The cans are of sufficiently heavy material so that danger of their being cut or dented is minimized. The riveted and soldered construction largely precludes the probability that leaks will develop at the seams. The handle, filling hole, and spout are protected, yet no damage will result if tools, boxes, or other equipment are piled on top of the cans. Because of its flat shape, this container may be carried in the hand much more readily than a round can of equal or smaller capacity. The flat shape also lends itself admirably to back packing or horse packing, where this is necessary.

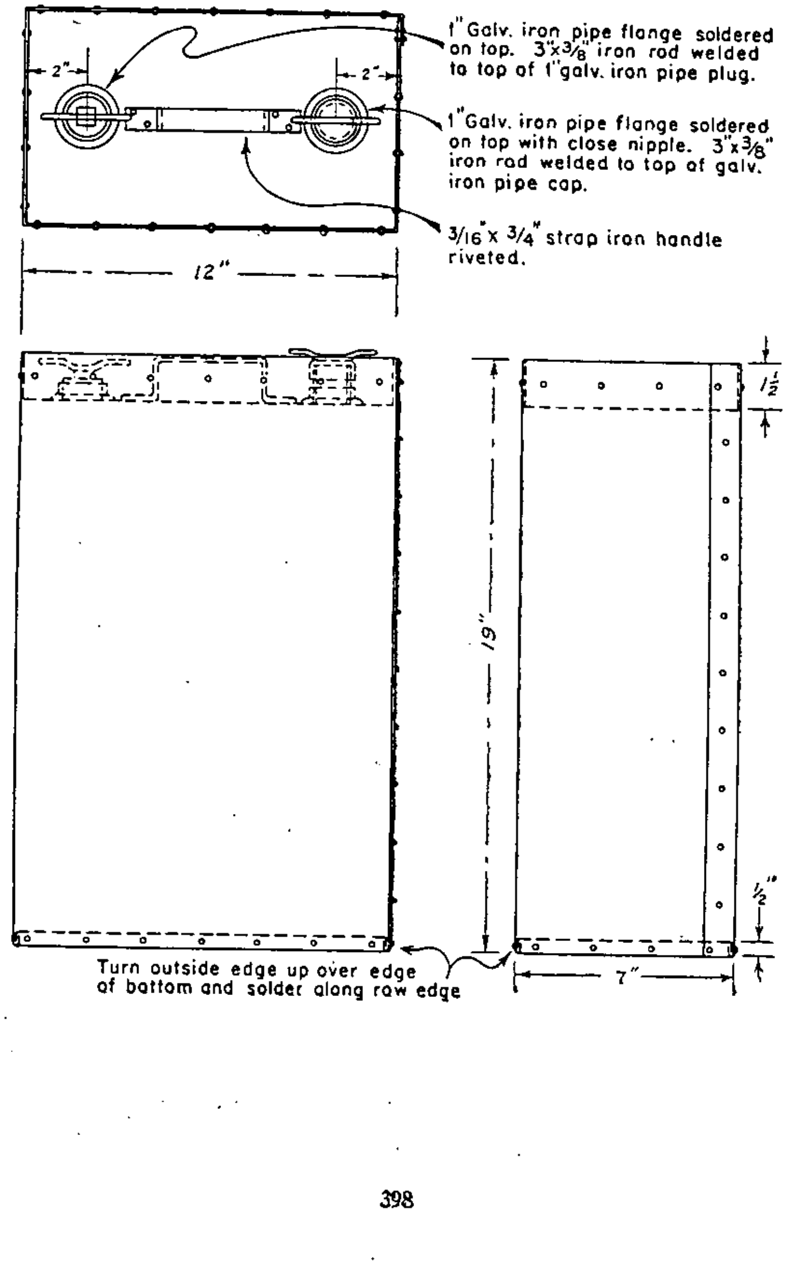
The capacity of the cans is such that five gallons of gasoline, with oil added at the rate of one and one-half pints per gallon of gasoline (Pacific-Marine specifications for types N and Y), will fill it to all practical purposes. No damage will be done to the pumper beyond minor fouling of the plugs if five gallons of gasoline are put in the can and the can filled with the proper grade of lubricating oil.

If one is contemplating back packing such a can of pumper fuel, it is interesting to note that when the can filled with gasoline and oil in the proper proportions is lashed on a pack board the entire outfit will weigh very nearly 50 pounds.

The initial cost of this kind of a fuel container will probably be from two and one-half to three times as great as for ordinary round five-gallon cans. However, the life of the container may reasonably be expected to be in the same ratio to the life of ordinary round five-gallon cans.

FUEL CONTAINER FOR PORTABLE PUMPERS

Construct from 24 gauge galvanized sheet. All seams to be soldered and riveted every 2" along seam and within 1" of the end of every seam or corner.



QUESTIONS AND ANSWERS

The Questions and Answers Column, which made its first appearance on page 295 of the August issue, has not stimulated the hoped-for response. Here, however, answers are offered to Questions 3 and 4, referring to the training of fire dispatchers. They are submitted by J. W. Farrell, Division of Timber Management, Region 4.

Answer to Question 3:

It is possible to a degree to develop superintelligent fire dispatchers. Surely intensive training and diversified fire control experience will develop the average man, but I question whether it is possible or practical to develop a man who can perform adequate fire dispatching at all times and under all conditions without weighing the many variable factors. The progressive and successful fire dispatcher must search for new ways and means to gauge fire weather and fire behavior, and he must study fuel types and have an outline of available man-power.

The dispatcher needs training and experience, but he also needs the best guides available to supplement his judgment.

I believe the tendency is to overlook the fact that the fire dispatcher in many instances performs his work by steps. The initial attack and the follow-up with reinforcements are largely based upon the information furnished from time to time by the party reporting the fire. In many instances follow-up action is prompted by the reports of the lookouts. The fire dispatcher should be able to study the behavior and possible spread of the fire through the lookouts or others who are reporting the fire.

Answer to Question 4:

A. Basic factors to consider:

1. Probability of occurrence of fires—lightning, man-caused fires.
2. Fuel type—rate of spread, resistance to control.
3. Topography and exposure.
4. Wind.
5. Fuel moisture content.
6. Type or character of suppression forces available.
7. Transportation facilities.
8. Visibility.

B. How obtained:

1. By entering on maps areas of high risk—sawmills, logging operations, recreationists.

2. Accurate fuel type maps.
3. Considered as a part of fuel type mapping.
4. Half and two-inch wood cylinder records.
5. By building up lists of available man-power and by intensive training of organized crews and sufficient overhead.
6. Maps and charts showing transportation facilities available.
7. By providing visibility maps based upon systematic field surveys.
8. By preparation of guide charts.

C. All information should be shown on maps or on charts condensed to the absolute minimum. We should use care that maps, charts, and records are not too intricate and do not prove a burden to the dispatcher rather than a help.

Marking Fire Trails for Night Use—Crater Lake National Park rangers have developed a novel method of marking obscure unsigned fire trails by means of reflector buttons at the edge of truck trails. The method used is as follows:

To a 1 × 4 × 4-inch block of wood are fastened a number of ¾-inch reflector buttons, such as are used on highway warning signs. A hole is bored through each block for driving a nail. These blocks are fastened to trees at the road edge low enough so that the lights of fire trucks will pick them up.

The fire trucks carry extra blocks with buttons attached so that one can be left on the road edge when the first crew leaves the road for a fire, and along the route to the fire if off the trails, so that other crews can follow up.

A modification of this method would be to use a different number of buttons on the blocks (a smaller one would do) to indicate readily each of several trails which may leave a truck trail.—*L. F. Cook, Deputy Chief Forester, National Park Service.*

TIME SPACE SCALE, AN AID TO TRANSPORTATION PLANNING

KARL E. MOESSNER

Junior Forester, Upper Michigan National Forest

Coverage overlays necessary in transportation planning are easily and accurately plotted by means of an adapted Humphrey Time Space Scale[1] and a Chartometer[2].

When adapted for Forest Service use the scale consists of two main parts (illustration No. 1).

1. *A Space Scale*—graduated in miles and quarter miles and reading zero to ten miles at the scale of the map to be used for transportation planning.

2. *A Time Scale*—placed directly below the space scale with zero line corresponding, graduated in minutes and reading time required to travel from zero to ten miles.

By placing the time scale for all kinds of transportation equipment likely to be utilized on one composite scale (see illustration No. 2) the time required to travel any distance up to 10 miles over any type of road, by any kind of vehicle, appears in minutes directly below the distance traveled; and conversely the distance possible to travel appears directly above the time available. By making the time space scale agree with the scale of the map used, the planner is able to lay off directly, with a chartometer, the available minutes of travel time.

The following problem illustrates the method used in plotting coverage by means of a time space scale.

Problem—To plot the limits of the fifteen-minute coverage zone from Center No. 1 East along highway and connecting truck trails and roads (illustration No. 3). All travel on roads to be in ½-ton pickup, cross-country travel to be on foot.

Procedure 1—Set the map measurer at zero. Place it directly over the zero line on the time scale (illustration No. 4, Point A) and run the measurer *forward* until directly over the fifteen-minute point (B).

[1]This scale, a familiar item in Correspondence Courses of the U. S. Army War College, indicates time in minutes necessary to travel a known distance at a given rate, and is used by the officer as an aid in building up transportation schedules for units considered in theoretical military situations.

[2]The Chartometer, or map measure, is an instrument consisting of a small wheel geared to a pointer on a graduated face. As the wheel is run over a road on the map, the pointer registers map inches traversed. This instrument is especially valuable for use on crooked roads or trails.

2. Without moving the pointer, place the instrument on the map directly opposite Center No. 1 (illustration No. 3) at point A. Run the measurer *backward* along the highway until the pointer reads zero (B) and mark this point. It is the limit of the fifteen-minute zone along the highway.

3. Determine the travel time to the intersection of truck trail and highway by running the measurer *forward* on the map (illustration No. 3) from point A to point C, then *backward* on the scale (illustration No. 4) points A to C and indicate time, two minutes, at the intersection. In like manner indicate time at points D and B.

4. To run out the zone limit on a tributary road, set the measurer on zero, place it on truck trail scale (illustration No. 4) at two-minute mark (point C) and run forward to the fifteen-minute mark (point E). Then place the measurer on the map at the intersection of the roads (illustration No. 3, point C) and run it *backward* along the truck trail until the pointer reads zero at E. This point will be the limit of the zone on the truck trail. All points on secondary roads or trails are run out in like manner.

5. To indicate cross-country travel at intermediate points, indicate time to points as at F (illustration No. 3) and lay off balance of time by means of a compass set from Foot Travel Scale as F to 1 (illustration No. 4).

6. Connect all points marked as extremities of fifteen minutes in order to sketch outline of fifteen-minute coverage from Center No. 1.

7. Along straight roads, lay the scale directly on the map with edge parallel to the road, and mark points direct. On crooked roads the map measurer is faster and more accurate.

While the above procedure has been explained in detail as an illustration, in using this technique the planner should keep the requirements of his job in mind. The accuracy and detail necessary on a map to be used by a dispatcher is seldom justifiable in a general transportation plan of a forest. The technique, however, is flexible, and the planner should use such short cuts as are expedient in accomplishing his objective.

The adapted time space scale used in this article is a local table. It utilizes averages from road tests conducted on the Upper Michigan Forest only, and cannot be assumed to represent true averages for the region or country as a whole. Furthermore, all tests were made by equipment driven within the CCC speed limits, and might not apply should this agency cease to exist. The following description covers the steps necessary in adapting the scale, and may prove of value to any forest desiring to construct a table for its own use.

1. Classify all roads on the forest. This may be done by inspection, by actual driving tests or by any other feasible manner, but should result in a number of classes, such as Highway, Truck Trails, Rut Roads, etc., which may be further broken down into First, Second, and Third class.

2. Make road tests, over stretches of not less than five miles, on a number of roads in each class, using all types of equipment likely to be utilized for fire transportation purposes, and taking data in minutes for the course.

3. Make cross-country tests, using men equipped with standard fire tools, such tests to be over foot trails, through timber, and through swamp, or any other situation pecular to the forest concerned.

4. Average tests by equipment, by road, and by ground conditions, checking averages to determine if sufficient samples have been taken. The figure arrived at should be in minutes for the distance traveled.

5. To build up scale, plot distance in miles (to the scale of the map to be used) across the top of the paper. Indicate the average minutes of travel time directly under the distance traveled. Subdivide the space indicated by the parallel lines method into minutes or multiples of minutes.

Such a scale carefully constructed and backed by adequate field work will be found to be not only an aid to the fire planner, but an indispensable tool to the dispatcher when estimating the travel time factor of the probabilities of a going fire.

DESCRIPTION—This scale consists of:

(a) A ....inch = ... mile scale reading 5 chs. — 10 chs. (⅛ mile) and miles.

(b) A time scale .... = ... mile reading travel time in minutes for various types of equipment over various types of roads.

THE HUMPHREY TIME SPACE SCALE

as adapted for Upper Michigan, showing composite scale for all equipment and roads.

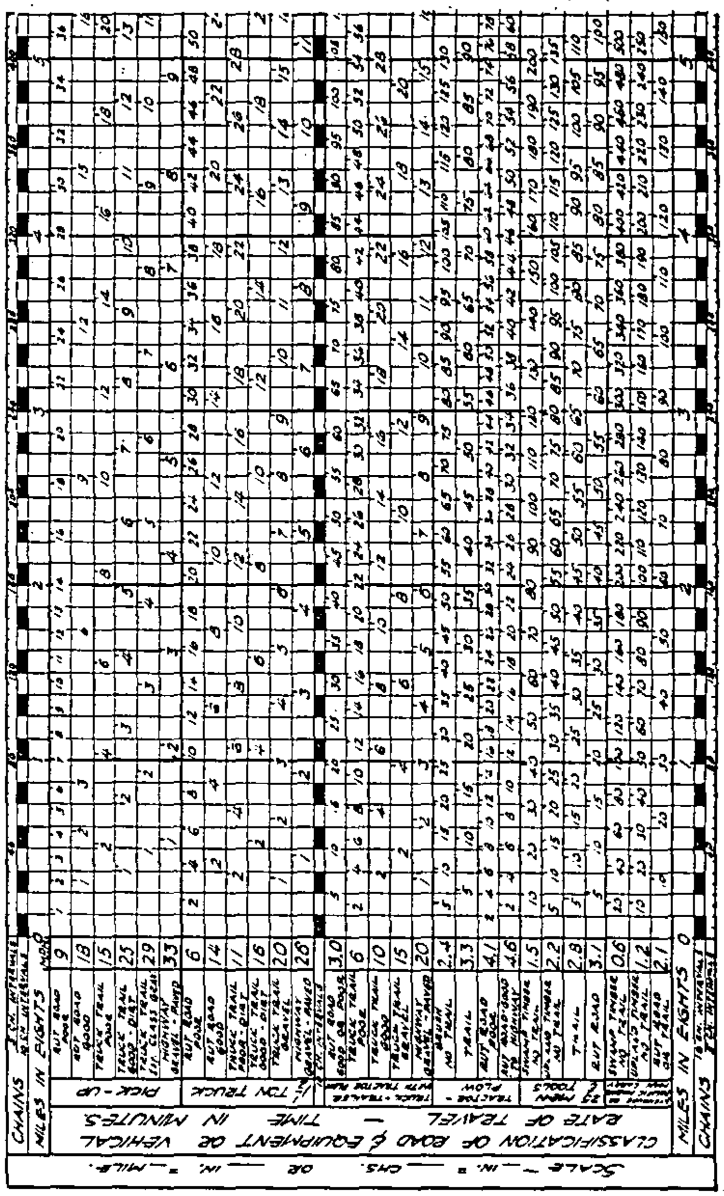


Illustration No. 2

HOW TO USE

(a) Knowing distance and rate of travel—time necessary appears on proper scale directly below the distance.

(b) Knowing equipment and time available. Distance possible to travel appears on mile scale directly above time.

(c) To use over crooked road. Set map measurer at zero and run over road. Then set measurer on zero line of proper scale and run backward until instrument registers zero. Read travel time at this point.

(d) To determine distance covered within given time. Set measurer at zero and run over proper scale until time limit is reached. Then run measurer backward from starting point on road until measurer reads zero.

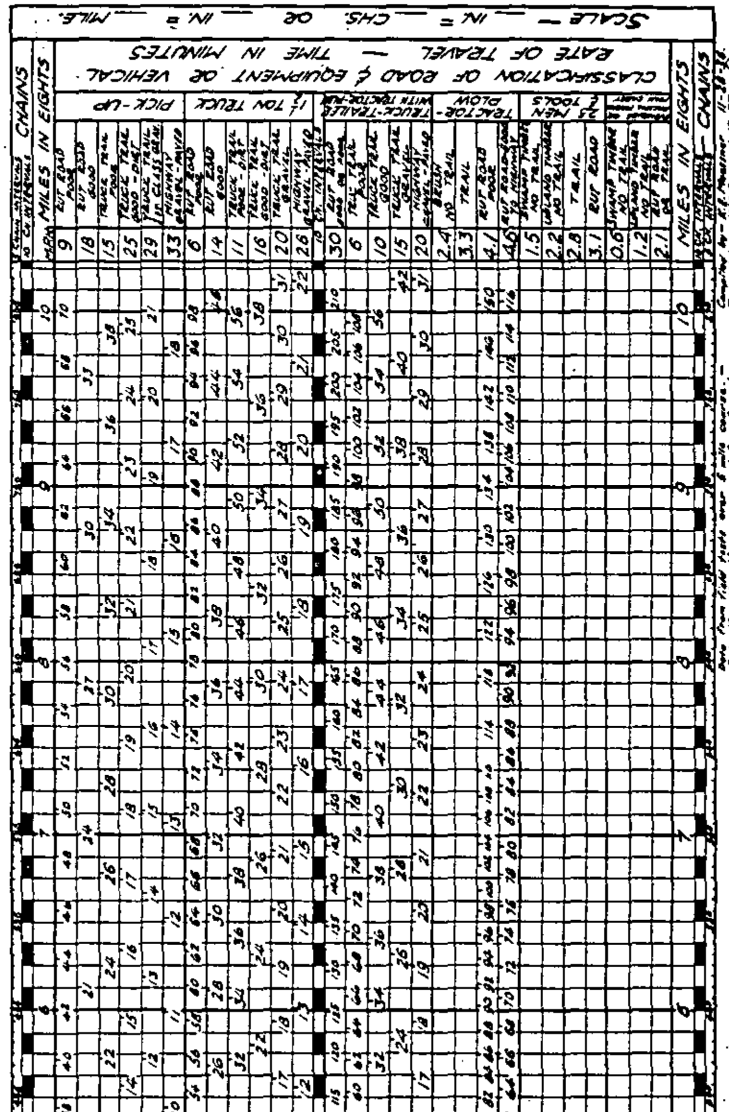
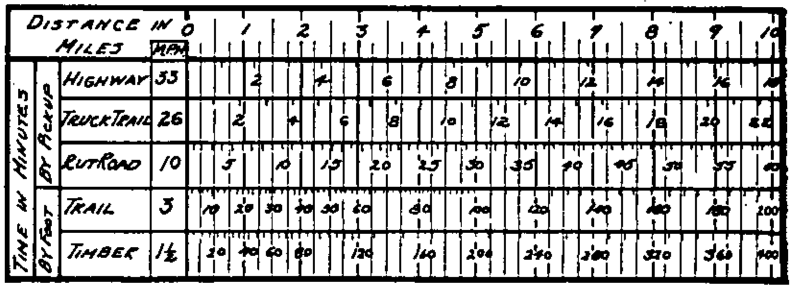


Illustration No 2 (continued)

HUMPHREY TIME SPACE SCALE

ILLUSTRATION No. 1



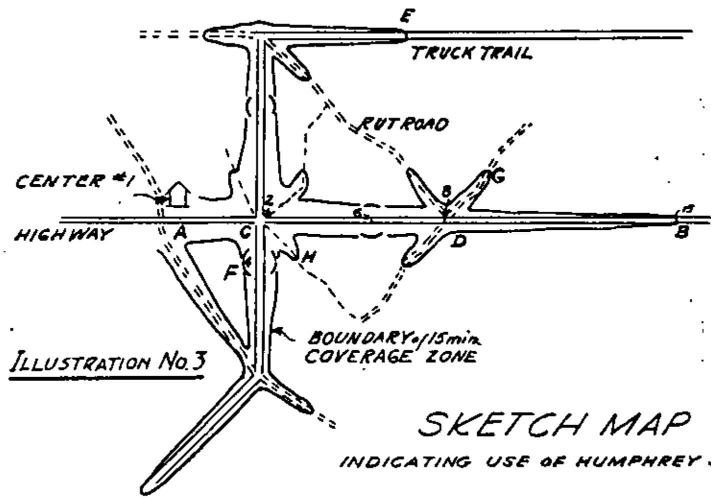
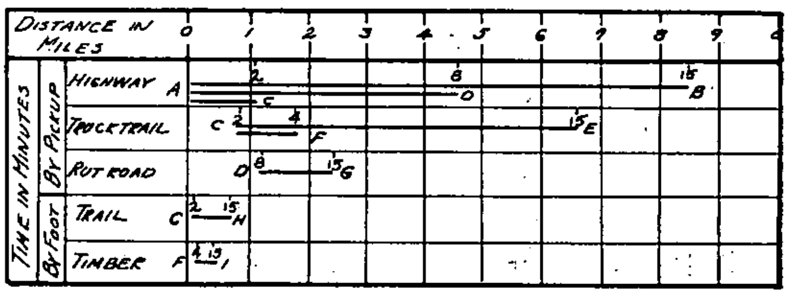


ILLUSTRATION No. 3

SKETCH MAP

INDICATING USE OF HUMPHREY SCALE

ILLUSTRATION No. 4



BY KARL E. MOESSNER

DRY ICE AND FOREST FIRES

A. B. EVERTS

Assistant Forest Supervisor, Cleveland National Forest

The commercial uses of dry ice (CO_2) are many and varied. What is believed to be the first use of this substance as a source of power for water pressure in connection with tank trucks was demonstrated on the Cleveland National Forest early in 1937. The unit employed consists of two 25-pound-capacity converters, a pressure gauge, a live hose reel and hose, and a 50-gallon high-pressure water tank equipped with a safety pressure release valve. The total cost for labor and material was $167.

In use, 25 pounds of dry ice is inserted through an opening in the top of the converter, and the top closed. When the dry ice is thus confined it immediately creates a pressure against the lid which seals the converter. The rise in pressure is very rapid up to 75 pounds, at which point the gas, as it sublimes from the solid, becomes a liquid. When all of the solid is melted the converter contains a liquid on the bottom and gas on top. At 77° temperature a pressure of 933 pounds per square inch will register on the gauge. As gas is withdrawn from the top, enough liquid converts to gas to keep the pressure at 933 pounds until the last drop of liquid is gone.

The pressure in the converter may be stepped down to the desired working pressure by means of a control valve, such as is used on acetylene welding outfits, and carried through a high-pressure hose to the water tank. This pressure then forces the water through the hose line.

The unit, as constructed on the Cleveland Forest, is much heavier than is now believed necessary. The water tank was constructed of quarter-inch boiler plate, electrically welded, and actually tested at a pressure of 1,050 pounds. A safety valve, set to release (or "pop") at 200 pounds pressure, is provided as a safety measure. The converters, uncharged, weigh 96 pounds each. The entire unit, with two fully charged converters, weighs 767 pounds; the weight of the water is 416 pounds, making a total of 1,183 pounds. By using a lighter water tank, hose reel, and converter the weight could be greatly reduced. The metal boxes for carrying fire tools could also be eliminated.

The most suitable type of converter which has been brought to the writer's attention is manufactured by a Chicago firm at a cost of $30 apiece. A double battery of these weighs 195 pounds when fully charged. These have actually been tested at a pressure of 7,900 pounds, and are equipped with safety discs which blow at a pressure of 2,800 pounds.

We are purchasing dry ice at 3 cents per pound. Twenty-five pounds will discharge a 50-gallon tank from 7 to 10 times, depending upon the pressure used and the size of the nozzle opening.

At 100 pounds steady pressure the water tank was discharged in two and one-half minutes through a one-quarter-inch tip, throwing the water a distance of 60 feet. At the same pressure, but by using a nozzle with a one-eighth-inch opening, it took 9 minutes to completely discharge the tank. Our experiments have convinced us that 100 pounds of pressure is sufficient to discharge a unit of this size and produce a satisfactory stream for general use. It would seem, therefore, that a water tank capable of withstanding a working pressure of 200 pounds per square inch would be all that is required. The safety valve should be set to pop at 100 pounds pressure.

At this point we would like to emphasize the need for care in distinguishing between "working pressure" and pressure as it is commonly used. As an example: a railroad fitting, ells, tees, nipples, etc., are rated at 350 pounds working pressure, and can be used safely at such load, but are actually tested and rated at 2,200 pounds hydrostatic pressure. I. C. C. container specifications or reference to local Safety Commission requirements for such containers will usually provide satisfactory data for construction purposes.

At the present time several firms are manufacturing a CO_2 type of fire extinguisher. The principle involved in these extinguishers is as follows: CO_2 gas is forced into a high-pressure cylinder. The action that takes place in the cylinder is identical with that which takes place in the converter in which dry ice is used. Liquid is formed in the bottom of the cylinder and gas on top. An inside tube extends from the release valve down into the liquid, and when the valve is opened the gas on top forces out the liquid, sometimes called "dry-ice-snow." This "snow" is spread or "fogged" by a funnel-like nozzle, and is one of the best fire extinguishing agents known. The cost, locally, to recharge these cylinders is $4.75. When dry ice is used the recharging costs but 75 cents. Thus, by equipping the converters with inside tubes and another set of valves, one would have an effective device for extinguishing gasoline and oil fires, as well as forest fires.

Among the advantages of this unit over the regular tank trucks are:

1. Its low cost.

2. Portability—the unit is constructed on an angle-iron framework, and can be carried on stake-sides, dump trucks, or pick-ups.

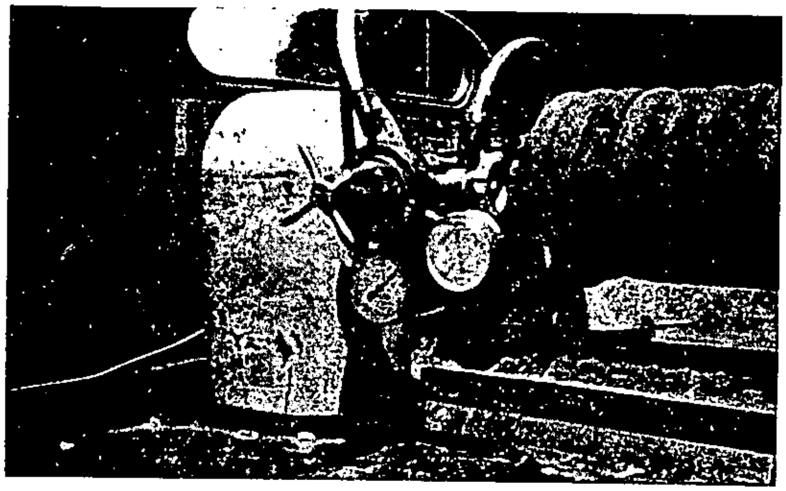
3. Since no power is furnished from the engine, the water does not cease to flow when gears are being shifted, such as is the case with pumps which are operated by a power take-off from the motor.

Some disadvantages are: With two converters, after from 14 to 20 tanks have been discharged (700 to 1,000 gallons), more dry ic is required. Also, tanks must be gravity filled, as the drafting problem has not as yet been completely solved.

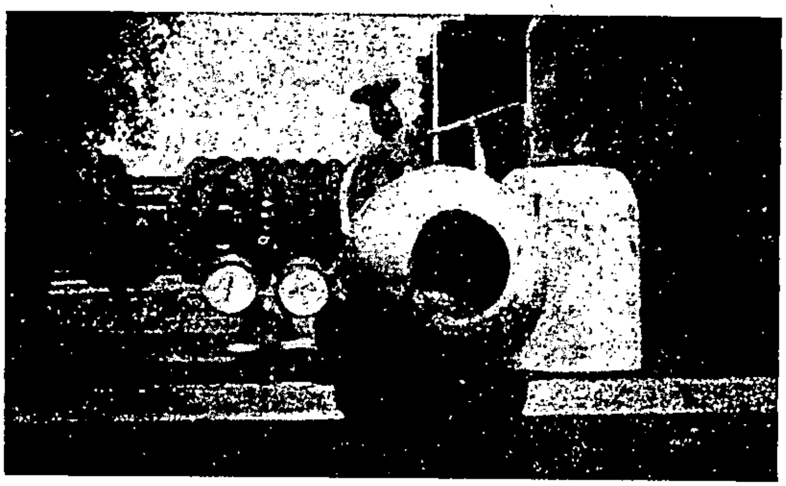
This type of equipment should be quite effective for logging operations. The unit, built on a speeder or trailer, would be ready for instant call without tying up motorized equipment.

The potential value of equipment of this type is obvious when one considers the cost factor and flexibility of use. Units of this type are comparatively inexpensive, and provide a means by which any available motor vehicle can be converted to an initial action tank truck. While we have not had sufficient opportunity to test the unit under all conditions, our limited experience indicates that the development is sound and practicable for field use.

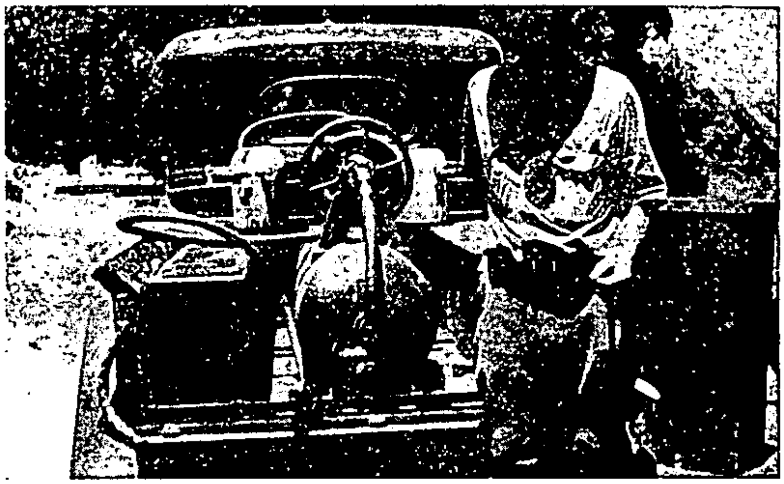
Further experimentation will be carried on to explore the field, and it appears quite certain that a practicable and safe unit will be available for general use within the next few months. As soon as detailed constructional information is ready for distribution, it probably will be issued through FIRE CONTROL NOTES. For the present, pending conclusion of our experiment, we wish to leave with the field the thought that while the unit still is somewhat in the laboratory stage, a useable piece of equipment is in prospect, and it will be our pleasure to furnish interested agencies with constructional and operating data.



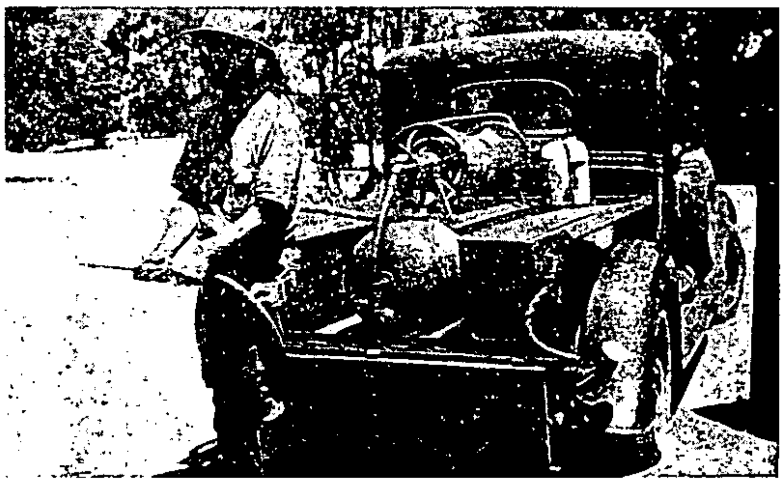
Close-up view of converter, gauge, and live reel hose. The gauge on the right registers the pressure in the converter, while the left gauge registers the "working pressure," or the pressure at which the water is forced from the water tank.



Close-up of empty converter, showing opening through which dry ice is inserted in recharging



View of the unit, constructed on angle-iron framework, inserted in truck body of a pick-up.



Water being discharged from the tank. Only one man is required to operate the unit. When the tank is empty, and the hose line shut off at the nozzle, gas ceases to flow into the empty water tank.

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and that no paragraphs be broken over to the next page.

The title of the article should be typed in capitals at top of first page, and immediately underneath it should appear the author's name, position and unit.

If there is any introductory or explanatory information it should not be included in the body of the article, but stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Text for illustrations should be typed on strip of paper and pasted on back of illustration. All diagrams should be drawn with the type page proportions in mind, and lettered so as to reduce well. In mailing illustrations, place between cardboards held together with rubber bands. Paper clips should never be used.

The approximate position that illustrations bear to the printed text should be indicated in the manuscript. This position is usually directly following the first reference to the illustration.

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