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DIRECTIONS FOR SAMPLING COAL FOR  
SHIPMENT OR DELIVERY

BY

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## CONTENTS.

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	Page.
Introduction .....	5
Time of sampling.....	6
Collection of gross sample.....	6
Size of gross sample.....	6
Quantity represented by a gross sample.....	7
Storage of gross sample.....	7
Wagonload sampling.....	7
Carload sampling.....	8
Ship or barge sampling.....	9
Preparation of gross sample.....	9
Crushing.....	9
Halving.....	10
Quartering.....	11
Sealing and mailing.....	12
Publications on the utilization of coal and lignite.....	12

## ILLUSTRATIONS.

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PLATE I. Method of preparing gross sample.....	10
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# DIRECTIONS FOR SAMPLING COAL FOR SHIPMENT OR DELIVERY.

By GEORGE S. POPE.

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## INTRODUCTION.

In the field work of the Bureau of Mines need has arisen for a circular giving brief directions for sampling coal at points in the field where the conditions for sampling are not fixed and usually no such facilities are at hand for methodically collecting and preparing samples as are available at power plants that regularly receive and sample coal. Frequently there is need of sampling a special shipment of coal as it is loaded into railroad cars at the mine or as it is unloaded from railroad cars into bins or ships, and at such times there is need of printed instructions regarding hand methods of sampling. This paper has been prepared to meet the need stated and is issued in the hope that it will be of service in the collection and preparation by hand of samples of coal in the field.

The underlying principles as well as full details of methods are given in Bureau of Mines Bulletin 116.<sup>a</sup> That bulletin discusses the factors that influence the accuracy of sampling; considers the different constituents of coal as affecting its value; refers to the results of experimental sampling; describes and illustrates the mechanical preparation of samples; discusses the specification method for the purchase of coal and gives types of Government coal specifications; and gives specifications and details for the construction of sample containers, riffles, etc.

This paper deals with the sampling of coal after it has been mined. In connection with investigations relating to fuels belonging to or for the use of the United States Government, the causes of accidents in coal mines, the geologic relations of coal beds, and the value of the coal in the public lands, the Bureau of Mines and the United States Geological Survey collect many mine samples of coal from the face of the bed and these samples are analyzed each year in the

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<sup>a</sup> Pope, G. S., Methods of sampling delivered coal and specifications for the purchase of coal by the Government, 1916, 64 pp.

laboratories of the bureau. The method used by the bureau and the Survey in collecting mine samples, as described in a previous publication,<sup>a</sup> involves selecting a representative face of the bed to be sampled; cleaning the face; making a cut across it from roof to floor; rejecting or including impurities in this cut according to a definite plan as they are included or excluded in mining operations; reducing this gross sample by crushing and quartering to about 3 pounds; and immediately sealing the 3-pound sample in an air-tight container for shipment to the laboratory.

#### TIME OF SAMPLING.

Collect the sample when the coal is being loaded into or unloaded from railroad cars, ships, barges, or wagons, or is being discharged from supply bins, industrial-railway cars, grab buckets, or coal-conveyors. In case the coal is crushed at the place of sampling, the sample should be collected, if possible, after the coal has passed through the crusher. Do not collect samples entirely from the surface of coal in piles or bins, or in cars, ships, or barges, as samples so collected are generally unreliable. A reliable and representative gross sample can be collected only by taking portions of coal from different parts of the mass, and such opportunity is afforded only when the coal is being transferred from one carrier to another—mine cars to railroad car, railroad car to barge, or wagon to bin, etc.

#### COLLECTION OF GROSS SAMPLE.

Use a shovel for taking equal portions or increments to make up the gross sample. For slack or small sizes of anthracite, increments as small as 5 to 10 pounds may be taken, but for run-of-mine, or lump coal, the increments should be at least 10 to 30 pounds, depending on the size and weight of the pieces of coal and impurities being sampled.

Collect the increments regularly and systematically, so that the entire quantity of coal sampled will be represented proportionately in the gross sample, and collect them at such intervals that the gross sample will be of the required size. The gross sample should contain the same proportion of lump coal, fine coal, and impurities as the coal sampled. When coal is extremely lumpy, making difficult the collection of representative increments by shovel, break a quantity of the lumps and collect portions, as required, from the broken coal.

#### SIZE OF GROSS SAMPLE.

For run-of-mine or lump coal, the gross sample must not be less than 1,000 pounds. If the coal contains an unusual amount of im-

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<sup>a</sup> Holmes, J. A., The sampling of coal in the mine: Technical Paper 1, Bureau of Mines, 1911, 18 pp.

purities in pieces of considerable size, the gross sample should be about 1,500 pounds. For slack coal and small sizes of anthracite in which the impurities are in not abnormal quantities, or are not in pieces larger than three-quarter inch, a gross sample of approximately 500 pounds is sufficient. Whether the quantity of coal sampled consists of 1 ton, 500 tons, or more, the need of the gross sample being of the sizes stated is the same.

#### QUANTITY REPRESENTED BY A GROSS SAMPLE.

The number of gross samples that should be collected must vary for each consignment or shipment, and each case must be considered individually. For example, a shipment of 1,000 tons, of 20 railroad cars of 50 tons each, may be represented by one gross sample of approximately 1,000 pounds, if properly collected; but in case coal from several mines enters into the shipment and a separate gross sample from, say, four cars to represent the coal produced by one mine is desired, or if for some other reason a sample is desired from four of the cars, then to represent the coal in the four cars a gross sample of 1,000 pounds should be collected by taking approximately 250 pounds from each car. If, for example, another sample for eight of the cars is required, then approximately 125 pounds should be taken from each car. The sampler will, presumably, be instructed as to the number of gross samples desired, or the number of cars, or the coal each sample is to represent.

#### STORAGE OF GROSS SAMPLE.

As the shovelfuls or increments to make up a gross sample are taken, deposit them on a clean, tight, and smooth floor or place them in clean barrels, boxes, or other receptacles. Protect the sample from rain, snow, wind, and beating sun. Do not let cinders, sand, chip-pings from floor, or any other foreign matter get into the sample. Inspect boxes, barrels, buckets, or other receptacles each time before using, to insure that they are clean.

#### WAGONLOAD SAMPLING.

Collect shovelfuls of coal from each wagon, or every second or third wagon, as the coal is being loaded into or unloaded from the wagons, the number of shovelfuls and the number of wagonloads sampled being dependent on the number of loads that the gross sample is to represent. If the coal is unloaded by shovel, take shovelfuls from different parts of the wagon or wagons; but do not take all shovelfuls from similar points, as from the surface or the ends of

loads or from the very last coal remaining in the wagons. If dump wagons are used, take shovelfuls as the coal flows from the wagon; observing care, however, not to take shovelfuls from the very first or last coal running.

#### CARLOAD SAMPLING.

Collect the number of shovelfuls or increments of coal required to make up the gross sample from different points in the car or cars, from top to bottom and from end to end, while the coal is being loaded or unloaded.

In sampling a shipment of coal at the mine, take the shovelfuls or increments systematically and regularly as the coal is loaded into the railroad cars, so that the gross sample will represent the entire quantity sampled. The frequency of collecting the increments will depend on the number of cars of coal to be represented by the gross sample. If only one railroad car is to be sampled, collect from each mine car dumped the number of shovelfuls required to obtain a gross sample of the required size. If two or more cars of coal are to be represented by one sample, the gross sample should be collected by taking a shovelful of the coal dumped from each mine car or from every second, third, or fourth, etc., mine car, in order to have a gross sample of proper size, so that representative portions of coal will be taken in equal quantities from each car. In case the railroad cars differ in size the quantities taken from each car should be in proportion to the capacities of the cars. When coal is dumped from mine cars into railroad cars, the lumps usually roll to the bottom, hence shovelfuls should not be collected entirely from the bottom of the car, but should be taken systematically over the surface of the coal.

Sample the coal after it has been prepared for market. If the coal is washed or is passed over picking tables or if pickers are employed on the car to remove impurities, the sample should not be taken until the coal has had its final preparation. If the coal is picked after it is dumped into the car, the sample must be collected from within the car as the coal is being loaded and after the pickers have gone over it. If no pickers are employed on the car, the sampling may be done at some advantageous place on the tipple before the coal reaches the car.

In sampling coal being unloaded by hand from cars, the shovelfuls to make up the gross sample should be taken at regular intervals. Workmen unloading coal usually begin at one end of a car and shovel the coal out to the bottom so as to facilitate shoveling from the floor. As a result the load is exposed from top to bottom and an excellent opportunity is afforded for taking shovelfuls for the sample from different places in the face exposed as unloading pro-



gresses, and it is easy to obtain a final sample composed of shovelfuls from all parts of the load, from top to bottom and from end to end.

In sampling coal from dump cars, shovelfuls may be taken from the stream of coal being discharged, observing care not to collect portions of the first or last coal spilling from the car. Because of the suddenness with which coal may drop out of a railroad car and because of the momentum of the rapidly falling lumps, the collection of a satisfactory sample by attempting to catch shovelfuls may be impossible. In such event it may be necessary to collect shovelfuls of coal that has overflowed on the pier or the trestle deck or the sides of pockets. If beams 10 to 12 inches wide span the pockets immediately underneath the car a fairly satisfactory sample can often be collected in shovelfuls from the coal lodging on the beams.

#### SHIP OR BARGE SAMPLING.

In sampling a ship or barge, as in sampling a car, portions of coal should be taken in equal quantities and at frequent and regular intervals while the coal is being loaded or unloaded, so as to represent proportionate parts of the whole consignment. If the coal is unloaded by grab buckets, or into barrows or coal-conveying equipment, shovelfuls usually can be advantageously collected at regular intervals from the buckets, barrows, or equipment.

#### PREPARATION OF GROSS SAMPLE.

##### CRUSHING.

After the gross sample has been collected it must be systematically crushed, mixed, and reduced to convenient size for transmittal to the laboratory. The crushing may be done with a tamper or a sledge. If a suitable iron tamper or sledge is not available, a satisfactory tamper can be made from a piece of 6 by 6 inch timber, 12 to 15 inches long, by boring a suitable hole in one end and inserting a handle about 3 feet long and  $1\frac{1}{2}$  to 2 inches in diameter, and by screwing an iron plate on the other end. The handle should fit the hole snugly. By splitting the end to be inserted and loosely placing a wood wedge therein the handle will be firmly held in place when it is driven home.

Crush the sample on a smooth, clean, sheet-iron plate of suitable dimensions or on a solid floor. If a suitable plate or floor is not available, the crushing may be done on a heavy canvas. In crushing the sample, take care that no pieces of impurities fly out of it, and that no cinders, sand, chippings from the floor, or any other foreign substances get into it. Crush samples of the weight indicated in the

accompanying table so that no pieces of coal and impurities will be greater in any dimension, as judged by the eye, than specified for the sample before division into two approximately equal parts:

*Largest sizes of coal or impurities allowable in samples before division.*

Weight of sample to be divided:	Inch.
1,000 pounds or more-----	1
500 pounds-----	$\frac{3}{4}$
250 pounds-----	$\frac{1}{2}$
125 pounds-----	$\frac{3}{8}$
60 pounds-----	$\frac{1}{4}$
30 pounds-----	$\frac{1}{8}$ or 4-mesh screen.

The method of reducing by hand the quantity of coal in a gross sample must be carried out as prescribed below, even though the initial size of the coal or of any impurities be less than is specified in the table.

The progressive reduction in the weight of the sample to the quantities indicated in the table must be done by the following methods, which are shown in the accompanying illustration (Pl. I).

#### HALVING.

The alternate-shovel method of reducing the gross sample is to be repeated until the sample is reduced to approximately 250 pounds. Before each reduction in quantity the sample must be crushed to the fineness prescribed in the table.

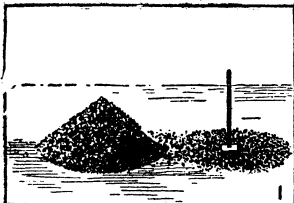
The crushed coal must be shoveled into a conical pile (figs. 2 and 7) by depositing each shovelful of coal on top of the preceding one, and then formed into a long pile in the following manner:

The sampler takes a shovelful of coal from the conical pile and spreads it out in a straight line (figs. 3, A, and 8, A) having a width equal to width of the shovel and a length of 5 to 10 feet. His next shovelful is spread directly over the top of the first shovelful, but in the opposite direction, and so on back and forth, the pile being occasionally flattened until all the coal has been formed into one long pile (figs. 3, B, and 8, B).

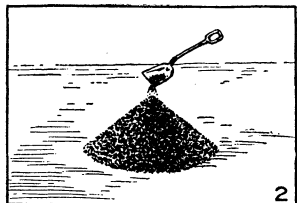
Half of the pile thus formed must be discarded in the following manner:

Beginning on one side of the pile, at either end, and shoveling from the bottom, the sampler takes one shovelful (shovelful No. 1, figs. 4 and 9) and sets it aside; advancing along the side of the pile a distance equal to the width of the shovel, he takes a second shovelful (shovelful No. 2, figs. 4 and 9) and discards it; again advancing in the same direction one shovel width he takes a third shovelful (shovelful No. 3, figs. 4 and 9) and adds it to the first. Shovelful

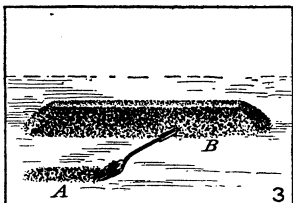
First stage in the preparation of 1,000-pound sample.



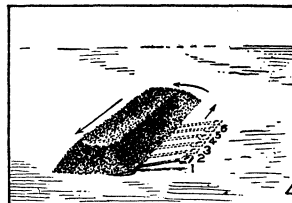
Crush 1,000-pound sample on hard, clean surface to 1" size



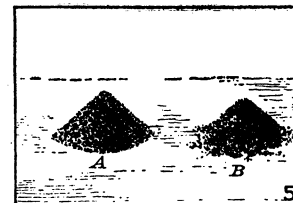
1,000-pound sample crushed to 1" and coned



Mix by forming long pile. A—spreading out first shovelful. B—long pile completed



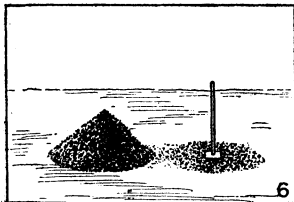
Halving by alternate shovel method. Shovelfuls 1, 3, 5, etc., reserved as 5, A; 2, 4, 6, etc., rejected as 5, B



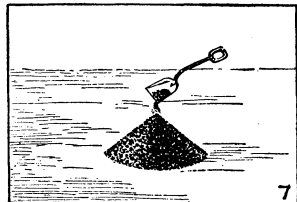
Long pile divided into two parts; A—reserve; B—reject

**NOTE**  
 SELECT A HARD, CLEAN SURFACE, FREE OF CRACKS AND PROTECTED FROM RAIN, SNOW, WIND, AND BEATING SUN. DO NOT LET CINDERS, SAND, CHIPPINGS FROM FLOOR, OR ANY OTHER FOREIGN MATTER GET INTO THE SAMPLE. PROTECT SAMPLE FROM LOSS OR GAIN IN MOISTURE

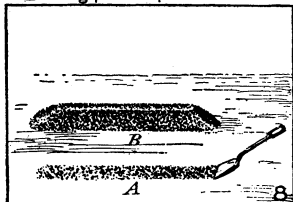
Second stage.



Crush 500-pound sample (fig. 5, A) to 3/4" size



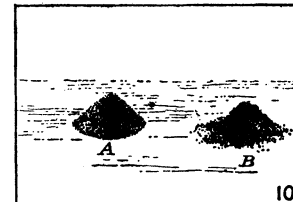
500 pounds crushed to 3/4" and coned



Mix by forming long pile. A—spreading out first shovelful. B—long pile completed

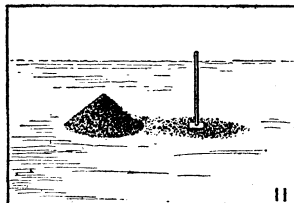


Halving by alternate shovel method. Shovelfuls 1, 3, 5, etc., reserved as 10, A; 2, 4, 6, etc., rejected as 10, B

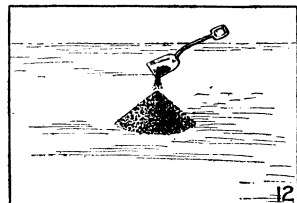


Long pile divided into two parts; A—reserve; B—reject

Third stage.



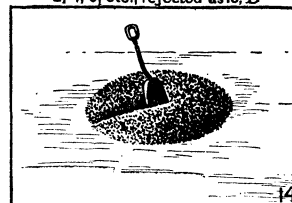
Crush 250-pound sample (fig. 10, A) to 1/2" size



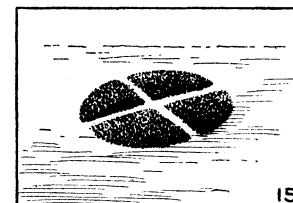
250-pounds crushed to 1/2" and coned



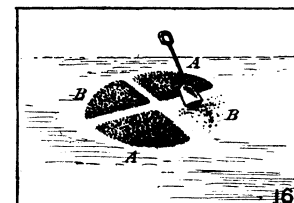
Mix by forming new cone



Quarter after flattening cone

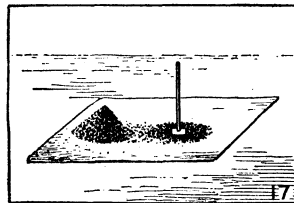


Sample divided into quarters

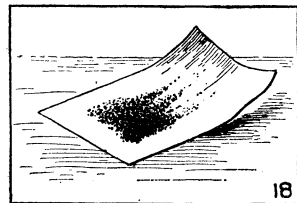


Retain opposite quarters A, A. Reject quarters B, B

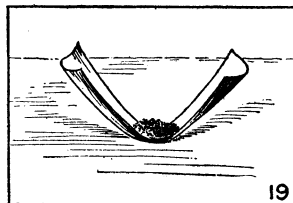
Fourth stage.



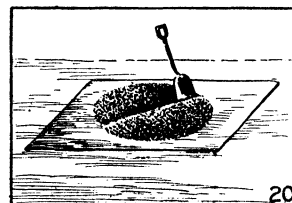
Crush 125-pound sample (fig. 16, A, A) on blanket to 3/8" size



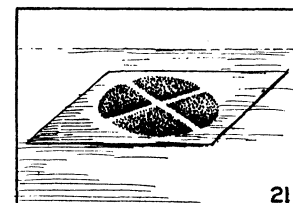
Mix by rolling on blanket



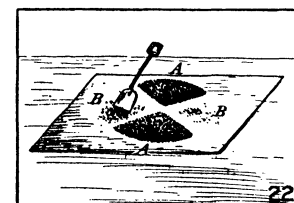
Form cone after mixing



Quarter after flattening cone

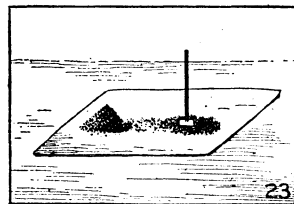


Sample divided into quarters

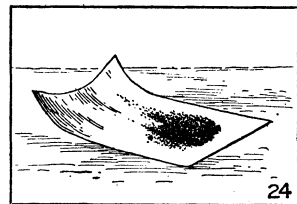


Retain opposite quarters A, A. Reject quarters B, B

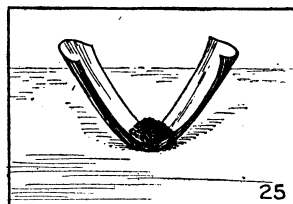
Fifth stage.



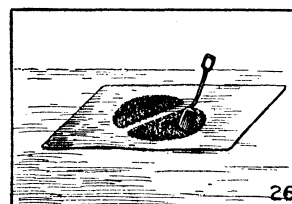
Crush 60-pound sample (fig. 22, A, A) to 1/4" size



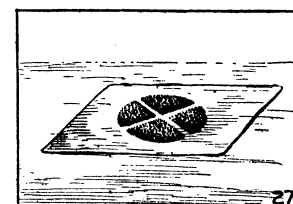
Mix by rolling on blanket



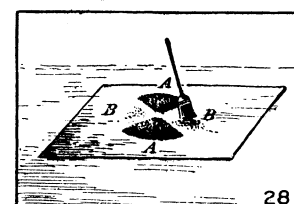
Form cone after mixing



Quarter after flattening cone

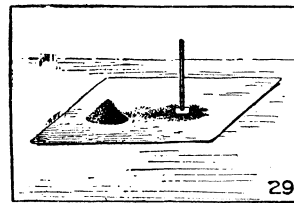


Sample divided into quarters

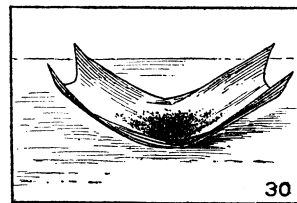


Retain opposite quarters A, A. Reject quarters B, B

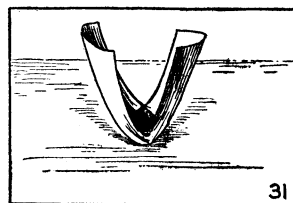
Sixth stage.



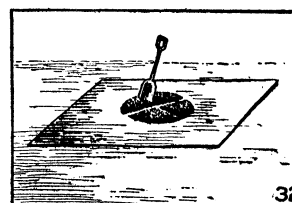
Crush 30-pound sample (fig. 28, A, A) to 3/16" or 4-mesh size



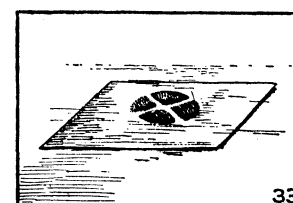
Mix by rolling on blanket



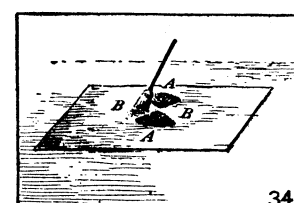
Form cone after mixing



Quarter after flattening cone



Sample divided into quarters



Fill two 5-pound sample containers from A, A, one for laboratory, one for reserve

METHOD OF PREPARING A SAMPLE OF COAL BY HAND. THE NECESSARY TOOLS ARE A SHOVEL, TAMPER, BLANKET MEASURING ABOUT 6 BY 8 FEET, BROOM, AND RAKE. THE COAL IS RAKED WHILE BEING CRUSHED, SO THAT ALL LUMPS WILL BE CRUSHED. FLOOR OR BLANKET IS SWEEP CLEAN OF DISCARDED COAL. EACH TIME AFTER SAMPLE IS HALVED OR QUARTERED.



No. 4 (figs. 4 and 9) is to be taken in a like manner and discarded, the fifth shovelful (No. 5, figs. 4 and 9) retained, and so on, the sampler advancing always in the same direction around the pile, so that its size will be reduced gradually and uniformly. When the pile is removed about half of the original quantity of coal should be contained in the new pile formed by the retained shovelfuls (figs. 5, A, and 10, A, show the retained halves, and 5, B, and 10, B, the rejected halves).

#### QUARTERING.

After the gross sample has been reduced by the above method to approximately 250 pounds, further reduction in quantity must be by the quartering method. Before each quartering the sample must be crushed to the fineness prescribed in the table.

Quantities of 125 to 250 pounds must be thoroughly mixed by coning and reconing (figs. 12 and 13); quantities less than 125 pounds must be placed on a suitable cloth, measuring about 6 by 8 feet, thoroughly mixed by raising first one end of the cloth and then the other (figs. 18, 24, and 30), so as to roll the coal back and forth, and then formed into a conical pile by gathering together the four corners of the cloth (figs. 19, 25, and 31). The quartering of the conical pile must be done as follows:

The cone is flattened by pressing its apex vertically down with a shovel or board, so that when the pile is quartered each quarter will contain the material originally in it. The flattened mass, which must be of uniform thickness and diameter, is then marked into quarters (figs. 14, 20, 26, and 32) by two lines that intersect at right angles directly under a point corresponding to the apex of the original cone. The diagonally opposite quarters (B, B in figs. 16, 22, 28, and 34) must then be shoveled away and discarded and the space that they occupied brushed clean. The coal remaining must be successively crushed, mixed, coned, and quartered until two opposite quarters shall equal approximately 10 pounds of  $\frac{3}{16}$ -inch, or 4-mesh, size. This 10-pound quantity must be thoroughly mixed and divided into two equal parts and each part placed in a container suitable for transportation. Mark one of these samples "original" and the other "duplicate" and forward the "original" to the laboratory, retaining the "duplicate" for forwarding in case the "original" should be lost or damaged in transit. If it is not convenient for the sampler to retain the "duplicate" sample, as when he is traveling from place to place, then the "duplicate" sample also should be forwarded to the laboratory.

In case a crusher that will break the coal to  $\frac{3}{16}$ -inch or 4-mesh size and a riffle are available for mechanically crushing and reducing

the sample they should be used instead of the hand method, as their use greatly facilitates the preparation of samples and tends to eliminate possible error by the sampler.

#### SEALING AND MAILING.

If metal containers,<sup>a</sup> are used two are required for the "original" 5-pound sample and two for the "duplicate," as the capacity of a container is only  $2\frac{1}{2}$  to 3 pounds. The double container used by the Bureau of Mines consists of a "damp-tite" paper case inclosed in a wooden shipping box and holds 5 pounds. To open the shipping box, insert nails, or any pointed instruments, in two holes in the box, thus releasing the spring catches.

As soon as the samples are prepared place them in the containers and seal the containers. The screw cap of the metal container has a rubber washer, but to insure tightness the cap, when in place and screwed down, should be wrapped carefully with several layers of adhesive (electrician's) tape, the first layer being pressed down with thumb and forefinger so that it completely covers the joint between the lower edge of the cap and the neck of the can. Seal the "damp-tite" case by wrapping the edge of the cap with tape.

Fill in forms for furnishing data concerning the sample and place (not paste) the form around the container. When metal containers are used each form should show the number of the can that carries the other half of the sample. As a safeguard against metal containers opening in transit and coal damaging the contents of a mail sack, wrap each can with several thicknesses of heavy manila paper and paste on or tie around the wrapped can the addressed franked mailing wrapper. Paste or tack on the box of the double container an addressed franked shipping tag. The containers are then ready for mailing.

Write a letter to the laboratory stating that the sample or samples, giving container numbers, have been forwarded.

#### PUBLICATIONS ON THE UTILIZATION OF COAL AND LIGNITE.

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<sup>a</sup> For specifications for size and construction of the metal can and the double shipping container, see Pope, G. S., Methods of sampling delivered coal: Bull. 116, Bureau of Mines, 1916, 64 pp.

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