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A STUDY OF METHODS USED IN MEASUREMENT AND ANALYSIS OF SEDIMENT LOADS IN STREAMS

REPORT AA

FEDERAL INTER-AGENCY
SEDIMENTATION INSTRUMENTS AND REPORTS

MAY 1959

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A Cooperative Project
Sponsored by the
Subcommittee on Sedimentation
Inter-Agency Committee on Water Resources
(Formerly Federal Inter-Agency River Basin Committee)

Participating Agencies

Corps of Engineers ** Geological Survey
Tennessee Valley Authority ** Office of Indian Affairs
Bureau of Reclamation ** Soil Conservation Service
Coast and Geodetic Survey ** Forest Service
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1. Introduction

Suspended-sediment samplers, bed-material samplers and a sand size analyzer developed by the Federal Inter-Agency Sedimentation Project are described in this report. A list of construction drawings for the instruments and a list of published reports are given. Development of these instruments and preparation of the reports was a cooperative project supported by a number of Federal Agencies concerned with sediment problems in streams, and sponsored by the Subcommittee on Sedimentation, Inter-Agency Committee on Water Resources. The cooperating agencies are

Corps of Engineers,
Tennessee Valley Authority,
Bureau of Reclamation
Coast and Geodetic Survey,
Federal Power Commission,
Bureau of Public Roads,
Geological Survey,
Office of Indian Affairs,
Soil Conservation Service,
Forest Service,
Agricultural Research Service,
Public Health Service.

The address of project offices of the cooperating agencies is the Federal Inter-Agency Sedimentation Project, St. Anthony Falls Hydraulic Laboratory, Hennepin Island and Third Avenue S. E., Minneapolis 14, Minnesota.

Communications regarding instruments, drawings, and reports may be addressed to District Engineer, U. S. Army Engineer District, St. Paul, Corps of Engineers, 1217 U. S. Post Office and Custom House, St. Paul 1, Minnesota, or to the project offices, Minneapolis.

Instruments may be procured by Federal Agencies from the U. S. Army Engineer District, St. Paul. Information regarding purchase of instruments by other than Federal Agencies may be obtained from either of the above offices.

This report was prepared May, 1959, by Frederick S. Witzigman.

2. Depth-integrating suspended-sediment wading-type hand sampler, US DH-48

This is a light-weight sampler for collection of suspended-sediment samples where wading rod sampler suspension is used.

The sampler consists of a streamlined aluminum casting, 13 inches long, which partially encloses a round pint milk bottle sample container (not furnished). The sampler weighs 4 1/2 pounds including sample container. A brass intake nozzle extends horizontally from the nose of the sampler body. A streamlined projection, pointing toward the rear on the side of the sampler head, accommodates the air exhaust port from which air may escape from the bottle as the sample is being collected. A standard 1/2-inch wading rod (not furnished) is threaded into the top of the sampler body for suspending the sampler. The sample container is held in place and sealed against a rubber gasket in the sampler head, by a hand-operated spring-tensioned clamp at the rear of the sampler. The instrument can sample to within 3 1/2 inches of the stream bed. The sampler is calibrated with a 1/4-inch inside diameter nozzle. A nozzle having a 3/16-inch bore may also be used. Photographs and a drawing of the sampler are shown in Figs. 1, 2, and 3.

In the sampling operation, the intake nozzle is oriented into the current and held in a horizontal position while the sampler is lowered into the stream. The sampler is lowered at a uniform rate from the water surface to the bottom of the stream, instantly reversed, and then raised again to the water surface at a uniform rate. The sampler continues to take its sample throughout the time of submergence. At least one suspended-sediment sample should be taken at each vertical selected in the stream cross section. A clean bottle is used for each sample.

Information on the sampler also is found in Report No. 6. A copy of operating instructions, Report J, is furnished with each purchased sampler.

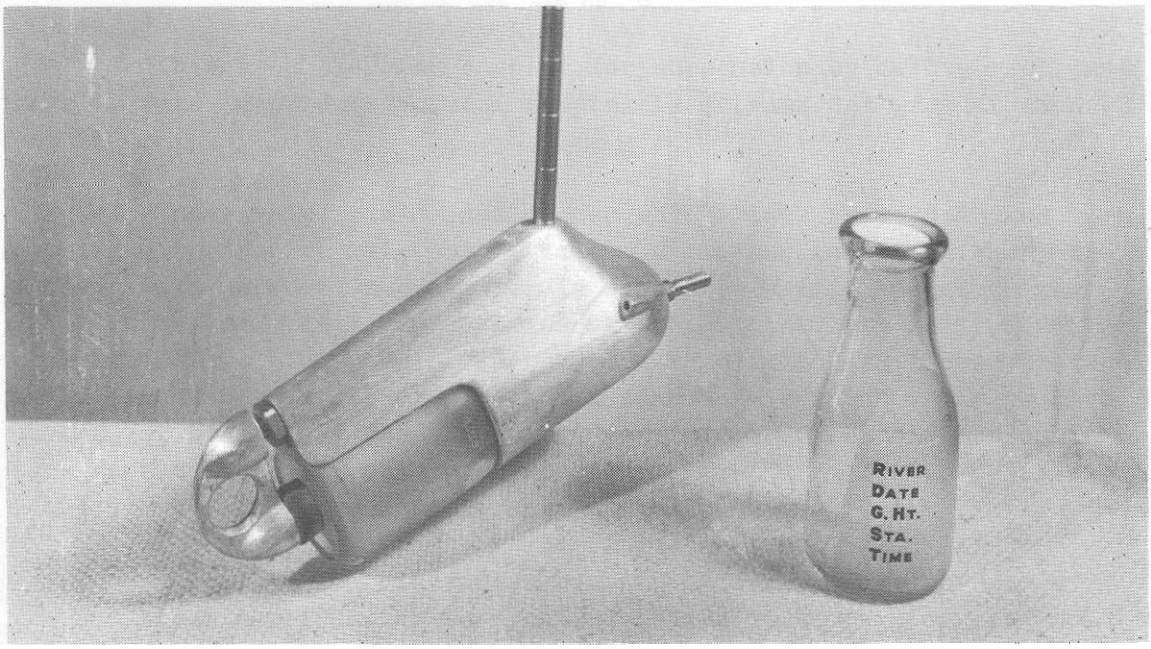


Fig. 1 Depth-integrating suspended-sediment wading-type hand sampler, US DH-48

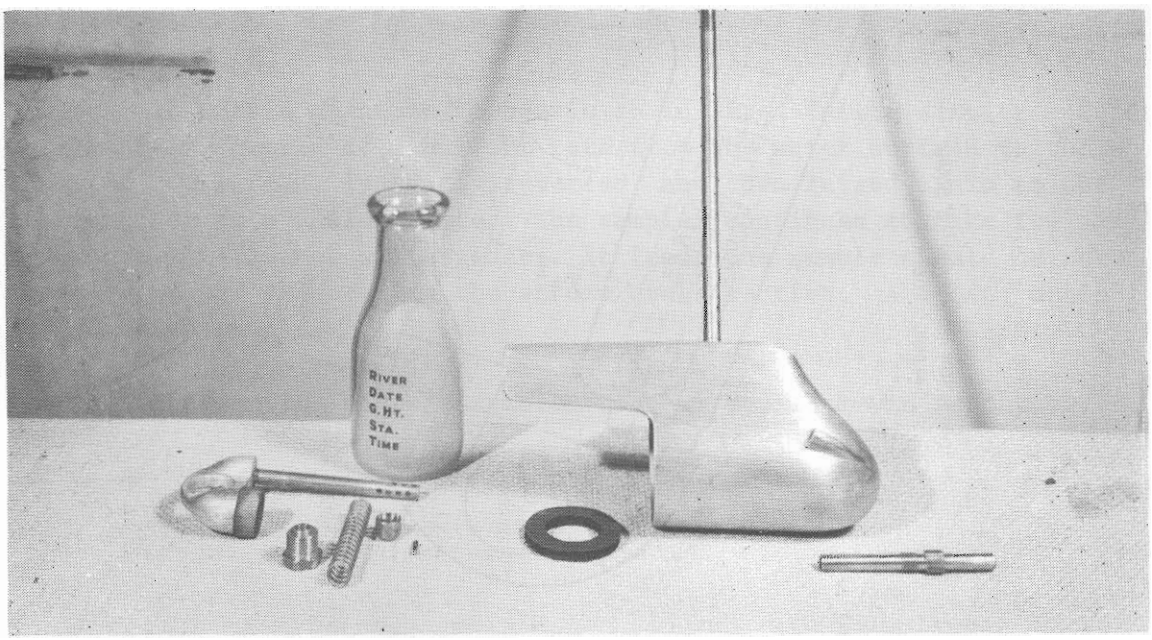


Fig. 2 Depth-integrating suspended-sediment wading-type hand sampler, US DH-48, disassembled

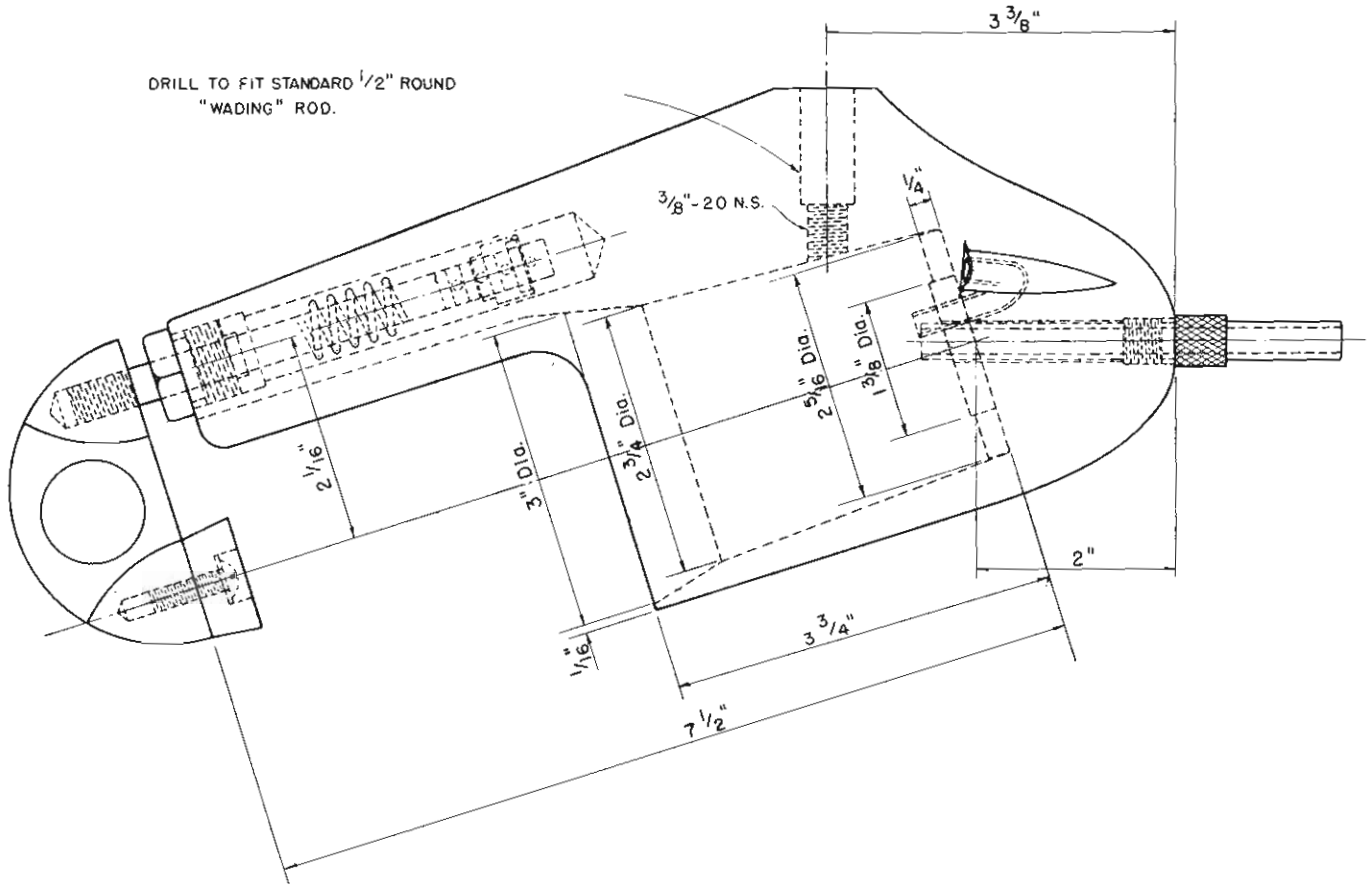


FIG. 3. DEPTH-INTEGRATING SUSPENDED-SEDIMENT WADING-TYPE HAND SAMPLER, USDH-48

3. Depth-integrating suspended-sediment sampler, US D-49

This is a 62-pound sampler for suspension by cable, reel, and crane to take suspended-sediment samples in streams not greater than 18 feet in depth.

The sampler has a cast bronze streamlined body 24 inches long, in which a round pint milk bottle sample container (not furnished) is enclosed. The head of the sampler is hinged to permit access to the sample container. Tail vanes are provided to orient the instrument into the stream flow. The head of the sampler is drilled and tapped to receive the 1/4-inch, 3/16-inch, or 1/8-inch intake nozzle which projects into the current for collecting the sample. A port which points downstream is provided on the side of the sampler head from which air escapes as it is displaced by the sample being collected in the container.

The instrument is suspended on a hanger bar attached to a 1/8-inch steel cable and is lowered and raised by means of a reel mounted on a crane. None of the equipment for suspension of the sampler is furnished. U. S. Geological Survey current meter hanger bar, reel, and crane are suitable for sediment sampler suspension. This instrument is generally operated from a bridge or cableway.

Photographs and drawing of the sampler are shown in Figs. 4, 5, and 6.

To obtain a sample, a bottle is inserted in the sampler and the instrument is lowered at a uniform rate from the water surface to the bottom of the stream, instantly reversed, and then raised again to the water surface at a uniform rate. The sampler continues to take its sample throughout the time of submergence. At least one sample should be taken at each vertical selected in the stream cross section. A clean bottle is used for each sample.

Information on this sampler also is available in Report No. 6.

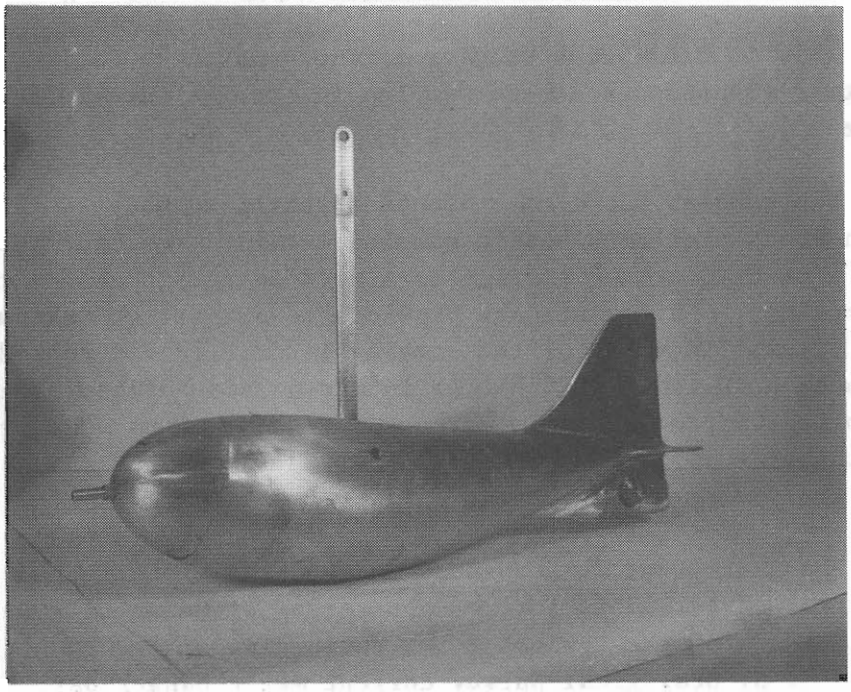


Fig. 4 Depth-integrating suspended-sediment sampler, US D-49

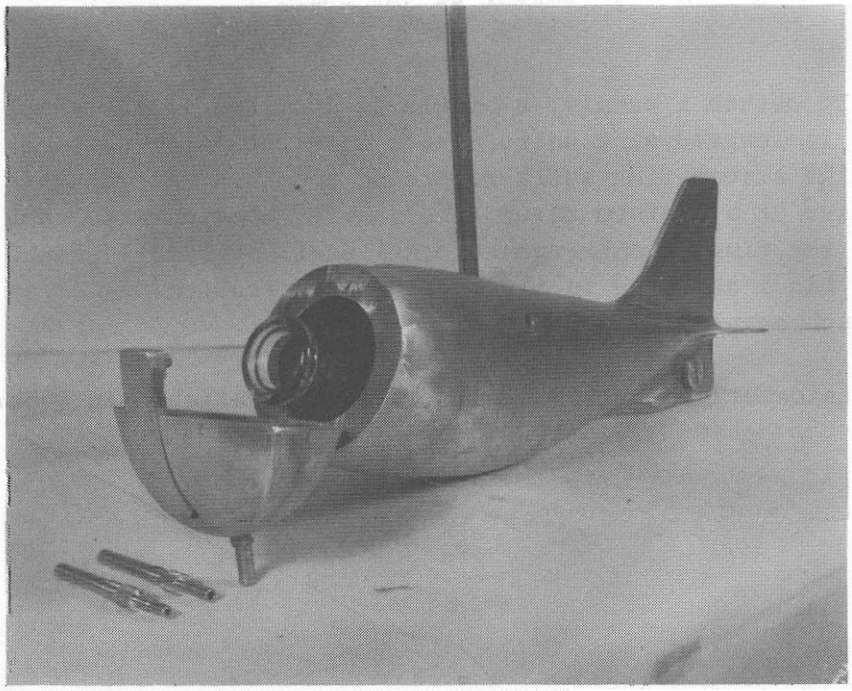


Fig. 5 Depth-integrating suspended-sediment sampler, US D-49, head open

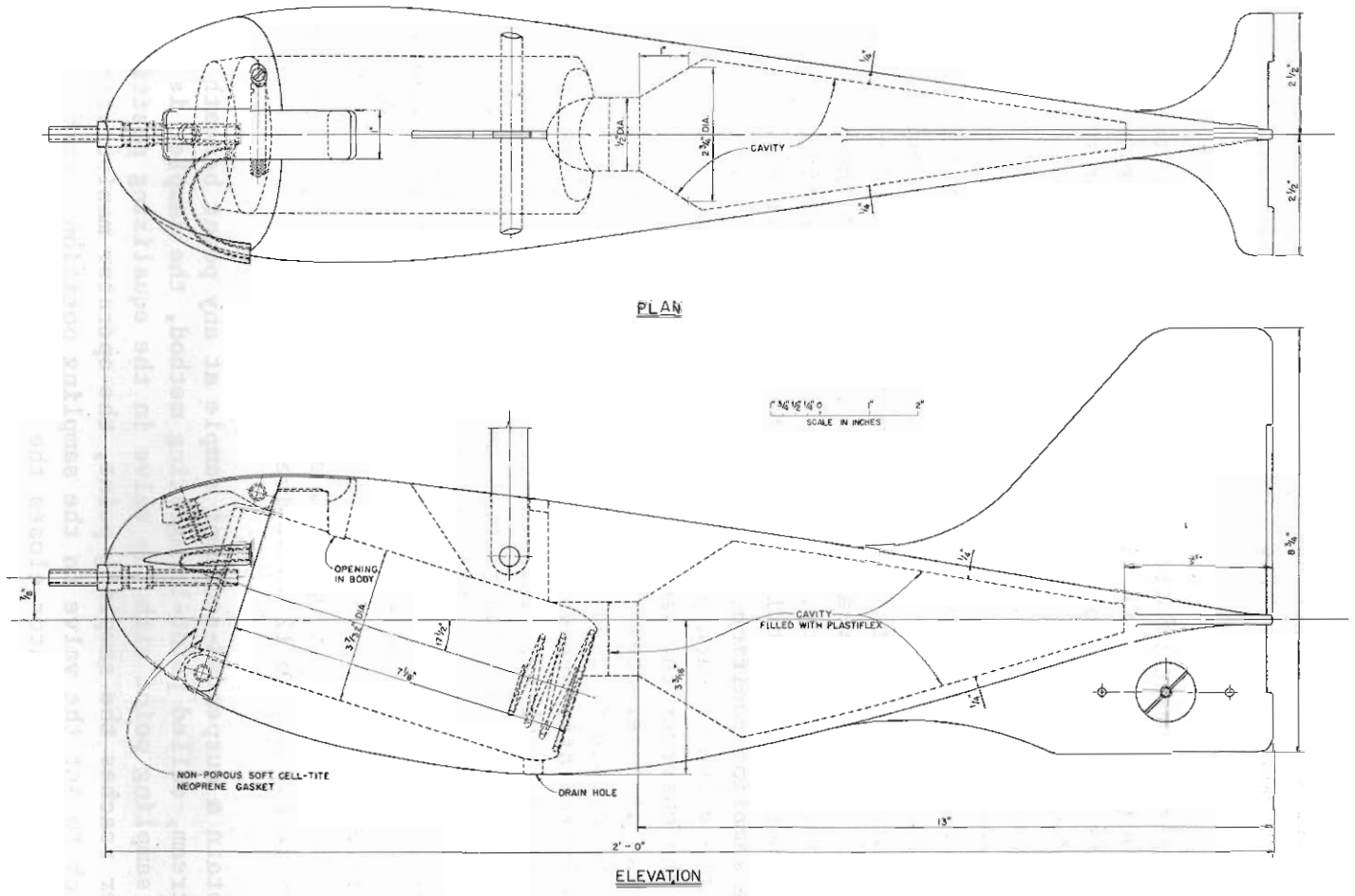


FIG. 6. DEPTH-INTEGRATING SUSPENDED-SEDIMENT SAMPLER, USD-49

4. Point-integrating suspended-sediment sampler, US P-46

This is a 100-pound sampler having an electrically operated valve for collection of a suspended-sediment sample at any point beneath the surface of a stream or for taking a sample continuously over a range in depth.

The sampler is made of cast bronze, 2 feet 2 inches long, streamlined and equipped with tail fins to orient it in flowing water. The sampler head is hinged to provide access to the round pint milk bottle sample container (not furnished) which is located in a cavity in the sampler body. A nozzle for collecting the sample projects into the current from the sampler head. An exhaust port pointing downstream on the side of the sampler head permits escape of air from the bottle as it is displaced by the sample being collected. Valve mechanism enclosed in the head of the sampler is electrically activated to start and stop the sampling process. The valve operating switch is located at the observer's station on the bridge or cableway. The valve has three positions, (1) to equalize the pressure in the bottle with the hydrostatic pressure at the nozzle, (2) the sampling position, and (3) the closed position. A rotary solenoid turns the valve to each position. A signaling device is provided to indicate to the observer the sampling position of the valve. To eliminate sudden inrush at a selected sampling point below the water surface, the diving bell principle is used to balance the air pressure in the bottle with the hydrostatic pressure at the nozzle prior to opening the valve at the start of sampling. This is accomplished through a body cavity which is connected by ports through the valve system to the surrounding stream and to the sample bottle. The sampler is supported by a hanger bar attached to a 1/8-inch steel two-conductor electrical suspension cable wound on a reel mounted on a crane (none of which are furnished). The electrical circuit in the suspension cable is for operation of the sampler valve. The equipment is operated from a bridge or cableway. The sampler is shown in Figs. 7 to 12 inclusive.

To obtain a suspended-sediment sample at any point beneath the surface of a stream, called point-integrating method, the sampler is lowered to the sampling point with the valve in the equalizing position. When the sampler reaches the sampling point, the operator manipulates the electrical switch to set the valve in the sampling position. At the end of the sampling time, the operator closes the valve electrically, raises the sampler out of the stream and removes the sample container. A clean bottle is required for each sample.

The sampler may be used to obtain a sample continuously over a range in depth, called depth-integrating method. If the stream is not

over 18 feet in depth with moderate velocity, the sampler valve is set in the open position and the sample is obtained by lowering the sampler at a uniform rate from the water surface to the bottom of the stream, instantly reversing it, and raising the sampler to the water surface again at a uniform rate.

If the stream is between 18 and 30 feet deep, or has a high velocity, the sampler may be used to depth-integrate in one direction, i.e., from the bottom of the stream to the surface. The sampler valve is set in the equalizing position and the sampler is lowered to the stream bed. The valve is then opened to the sampling position by manipulating the electrical switch and the sampler is immediately raised to the surface at a uniform rate.

Streams which are too deep or flow too fast to be depth-integrated by either of the above methods may be sampled by dividing the vertical into fractions each of which is depth-integrated individually.

Additional information on the US P-46 sampler may be found in Report No. 6. A copy of Operation and Maintenance manual, Report I, is furnished with each purchased sampler.

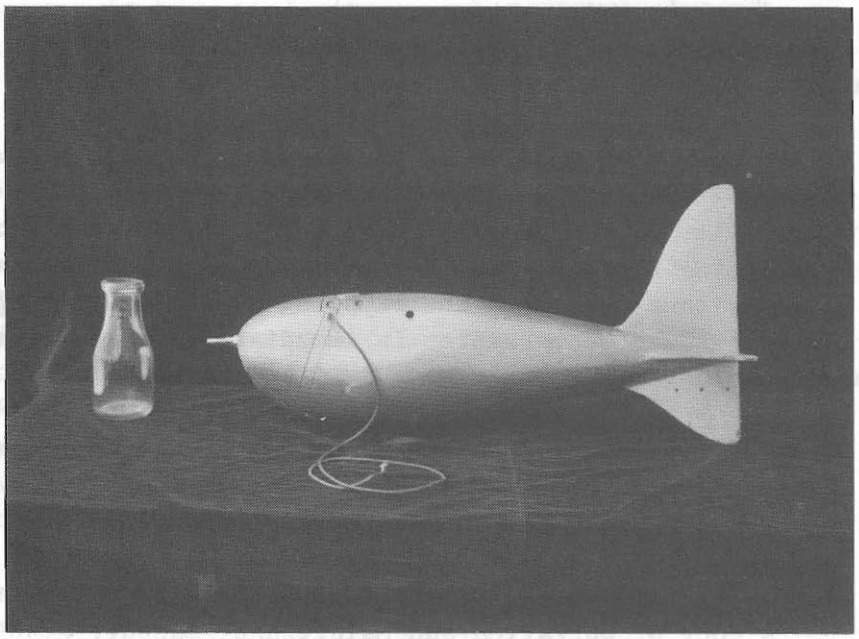


Fig. 7 Point-integrating suspended-sediment sampler, US P-46

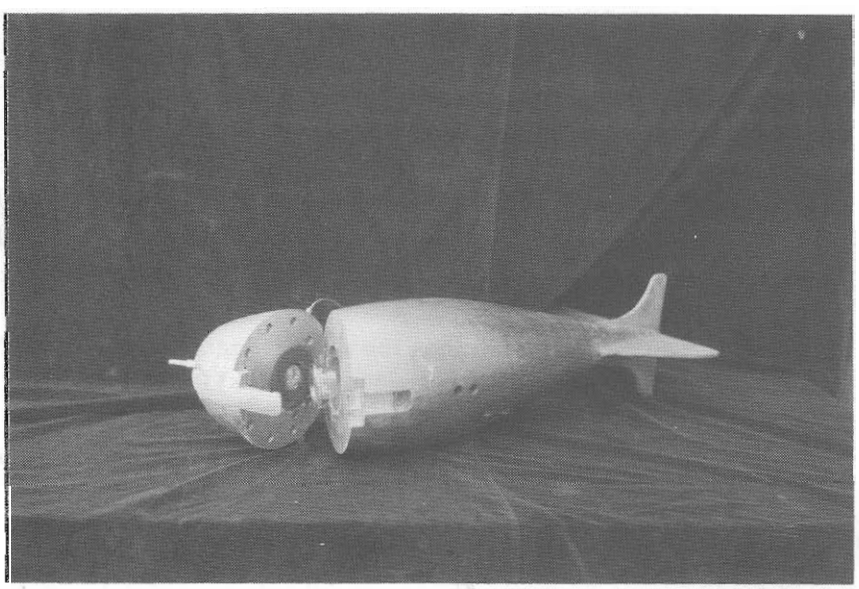


Fig. 8 Point-integrating suspended-sediment sampler, US P-46, head swung back

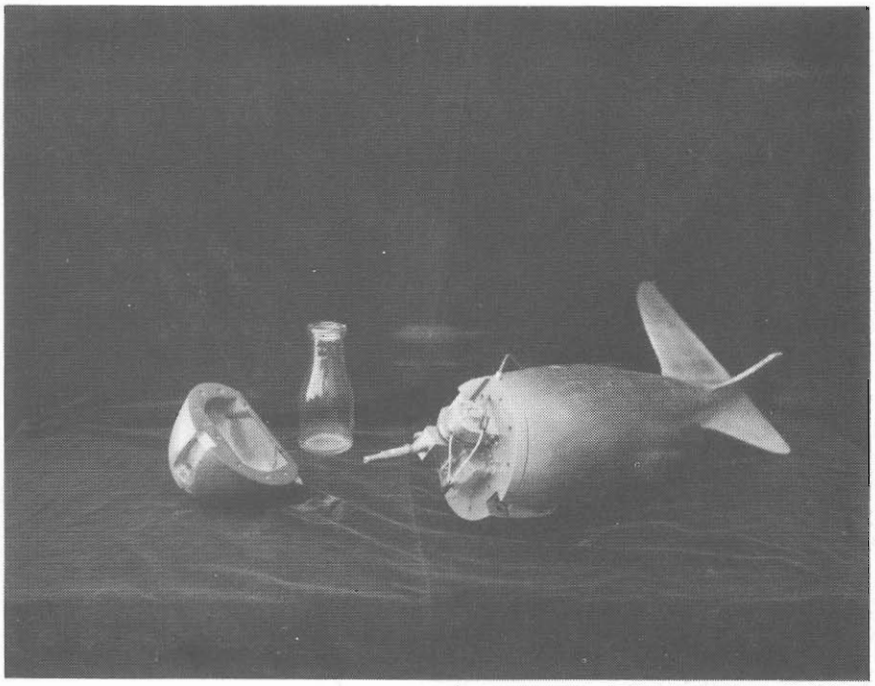


Fig. 9 Point-integrating suspended-sediment sampler, US P-46, head cover removed

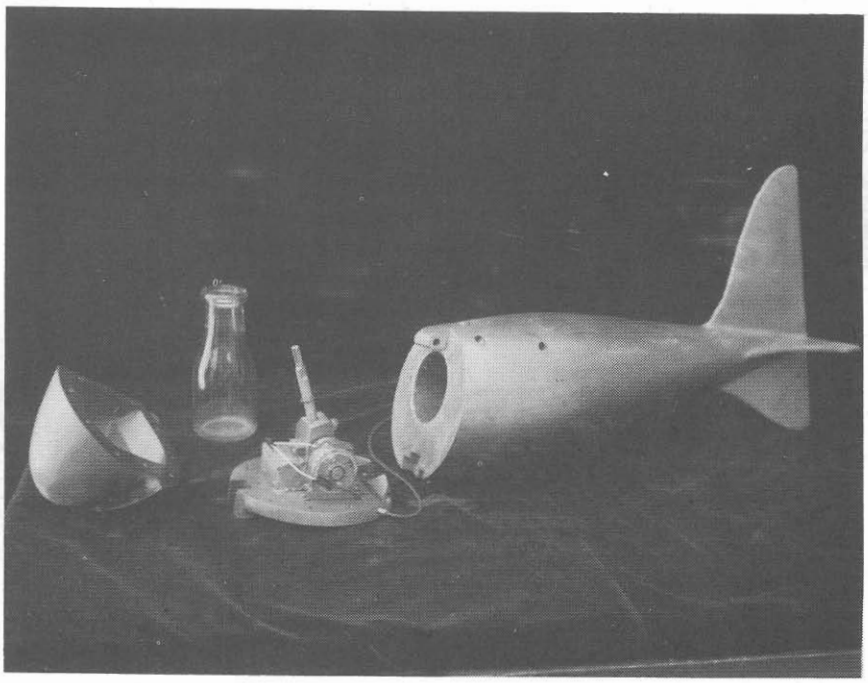


Fig. 10 Point-integrating suspended-sediment sampler, US P-46, head cover and head base removed

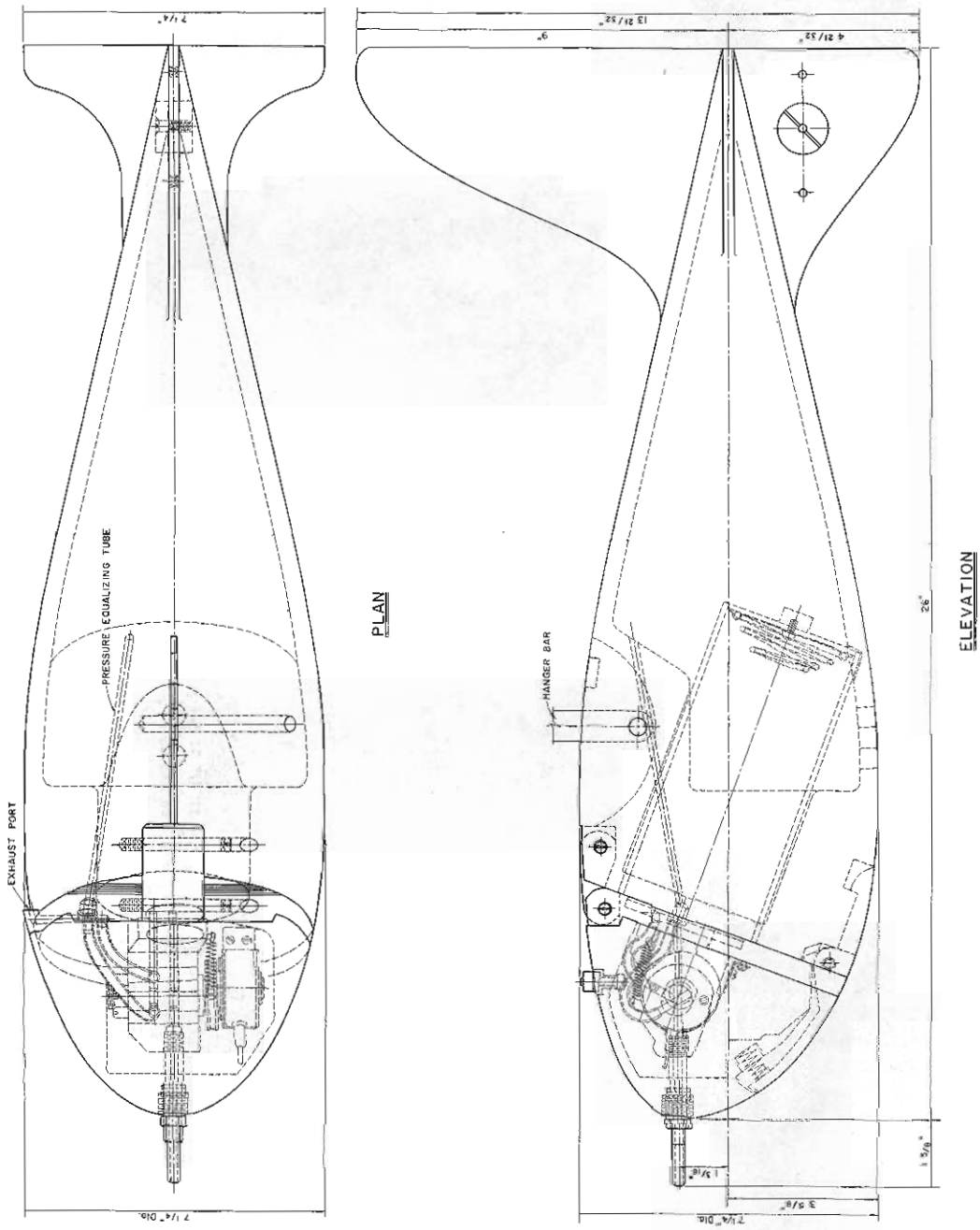


FIG. 11. POINT-INTEGRATING SUSPENDED-SEDIMENT SAMPLER, USP-46

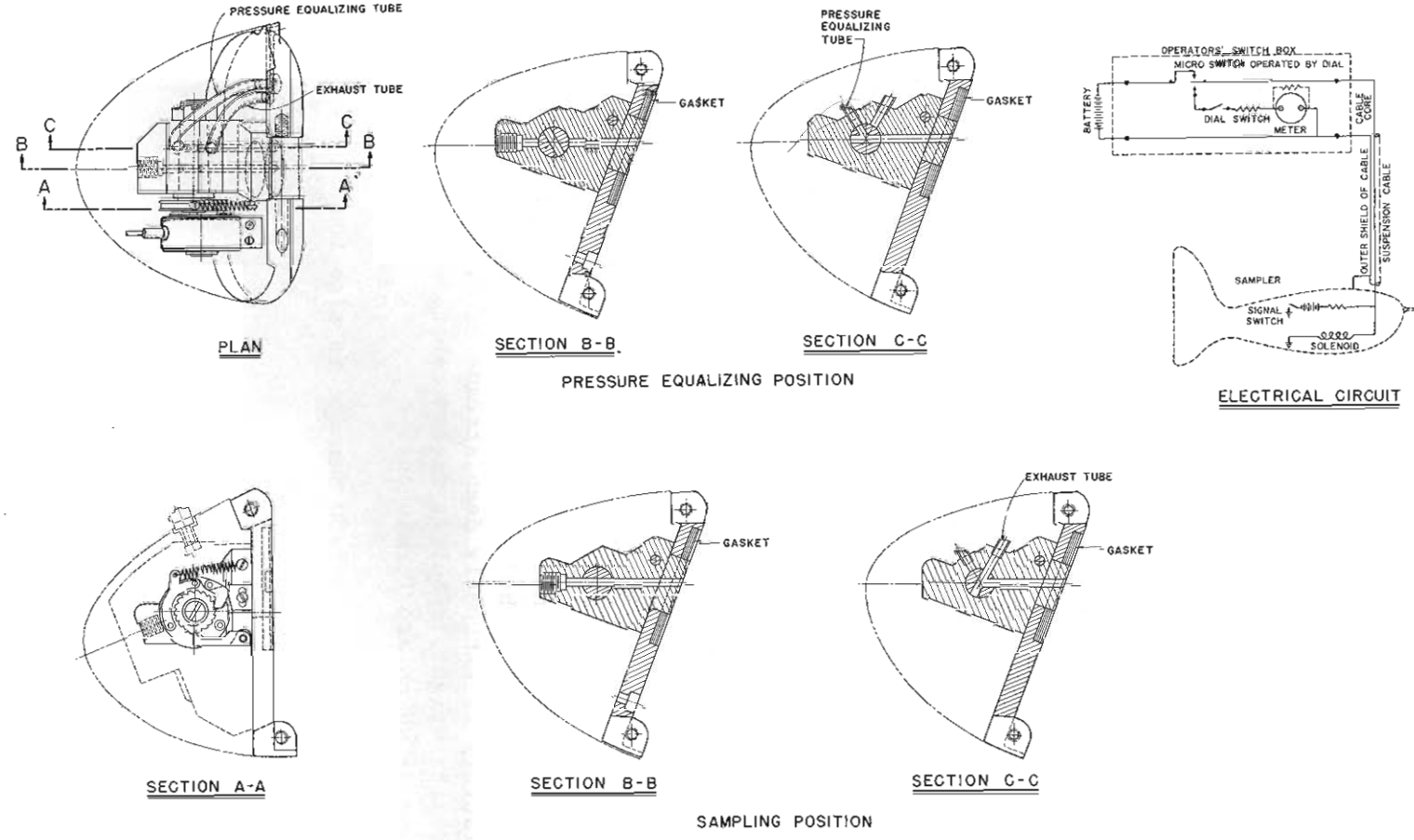


FIG. 12 POINT-INTEGRATING SUSPENDED-SEDIMENT SAMPLER, USP-46, VALVE MECHANISM

5. Point-integrating suspended-sediment sampler, US P-50

This is a 300-pound electrically operated sampler for collection of suspended-sediment samples at any point beneath the surface of a stream, or for taking a sample continuously over a range of depth in extremely deep streams of high velocity.

The sampler is made of cast bronze, 3 feet 8 inches long, is streamlined and equipped with tail fins to orient it in the stream. The sampler head is hinged to provide access to the round quart milk bottle sample container (not furnished). A nozzle for collecting the sample projects into the current from the sampler head. An exhaust port is provided to permit escape of air from the sample container as it is filled with the sample. An electrically actuated valve mechanism to start and stop the sampling process is located in the sampler head. The valve has two positions, (1) the equalizing position for balancing the pressure in the sample container with the hydrostatic pressure at the nozzle, during which intake and exhaust passages are both closed, and (2) the sampling position. The valve is held in the equalizing position by a spring. Solenoids, when electrically energized, hold the valve in the sampling position. The compression chamber in the body of the sampler permits operation to depths of 200 feet. The sampler is shown in Figs. 13 to 17 inclusive.

The sampler is used to take a suspended-sediment sample at any point beneath the surface of the stream or to obtain a sample continuously over a range in depth in a manner similar to that employed with a US P-46 point-integrating sampler. The US P-50 point-integrating sampler, however, is more satisfactory in extremely deep streams of high velocity. This sampler, due to its weight, requires rugged cable, reel, and crane suspension (none of which are furnished).

Information on the US P-50 sampler is also found in Report No. 6.

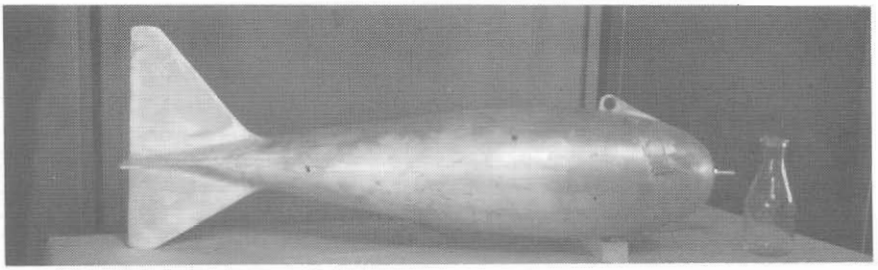


Fig. 13 Point-integrating suspended-sediment sampler, US P-50

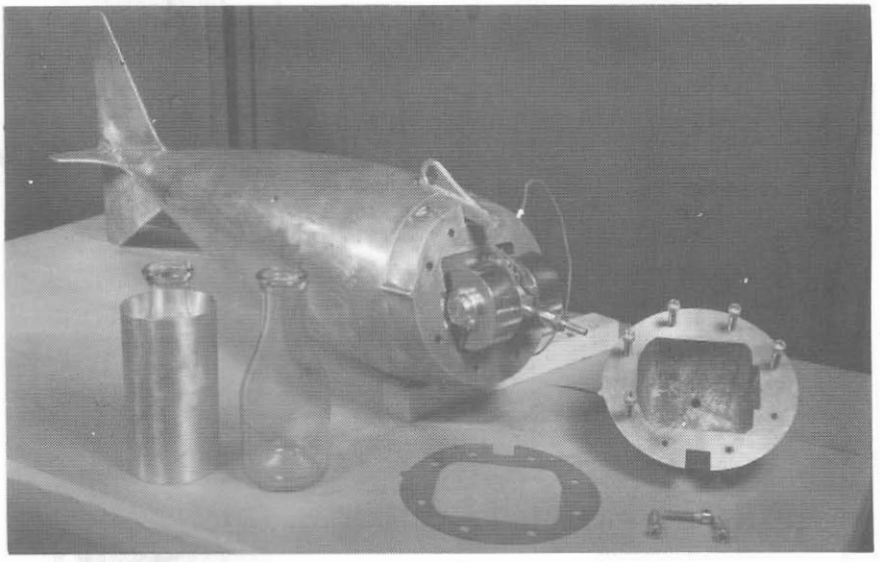


Fig. 14 Point-integrating suspended-sediment sampler, US P-50, head cover removed

Fig. 15 Point-integrating suspended-sediment sampler, US P-50, head cover and head base removed

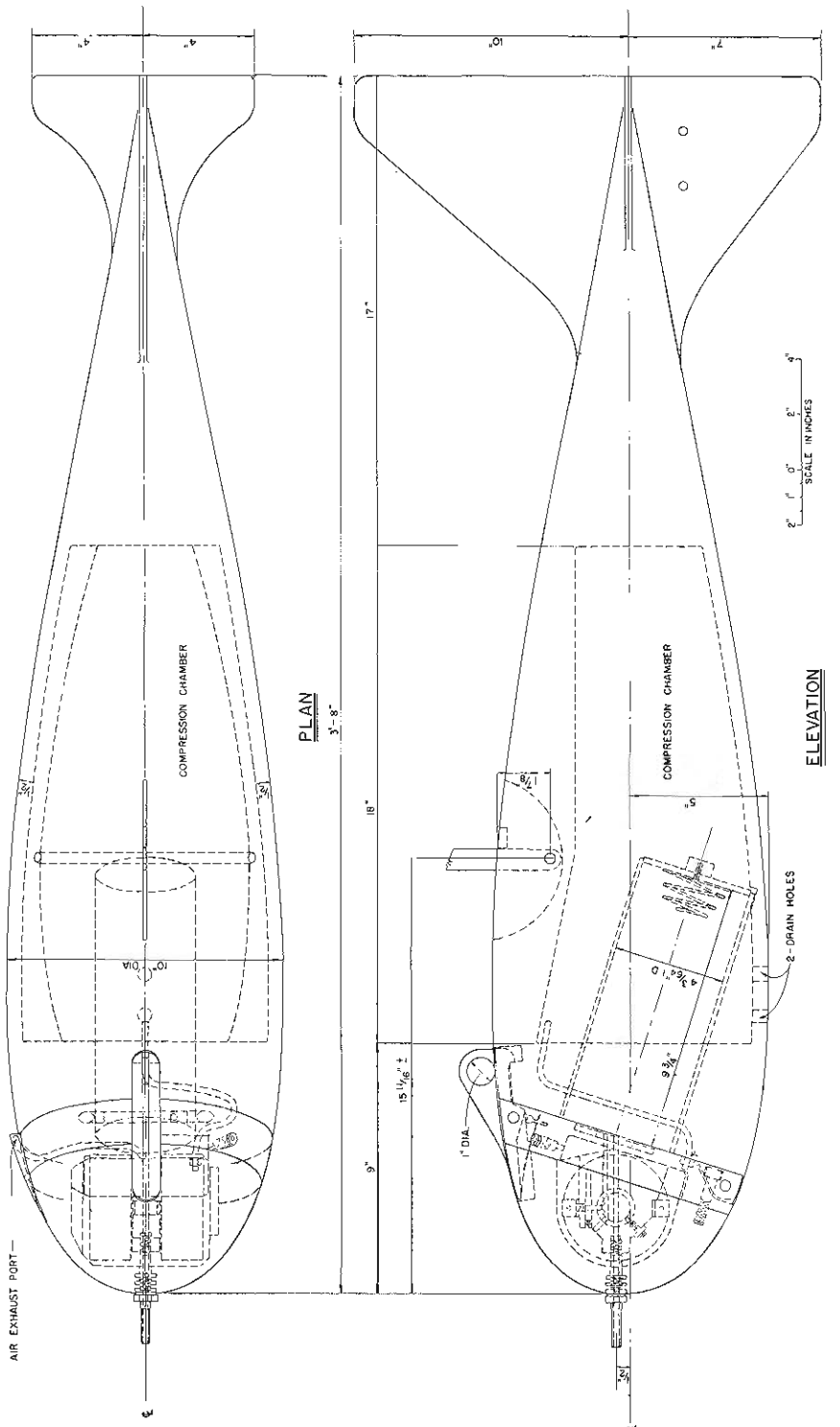


FIG. 16. POINT-INTEGRATING SUSPENDED-SEDIMENT SAMPLER, USP-50

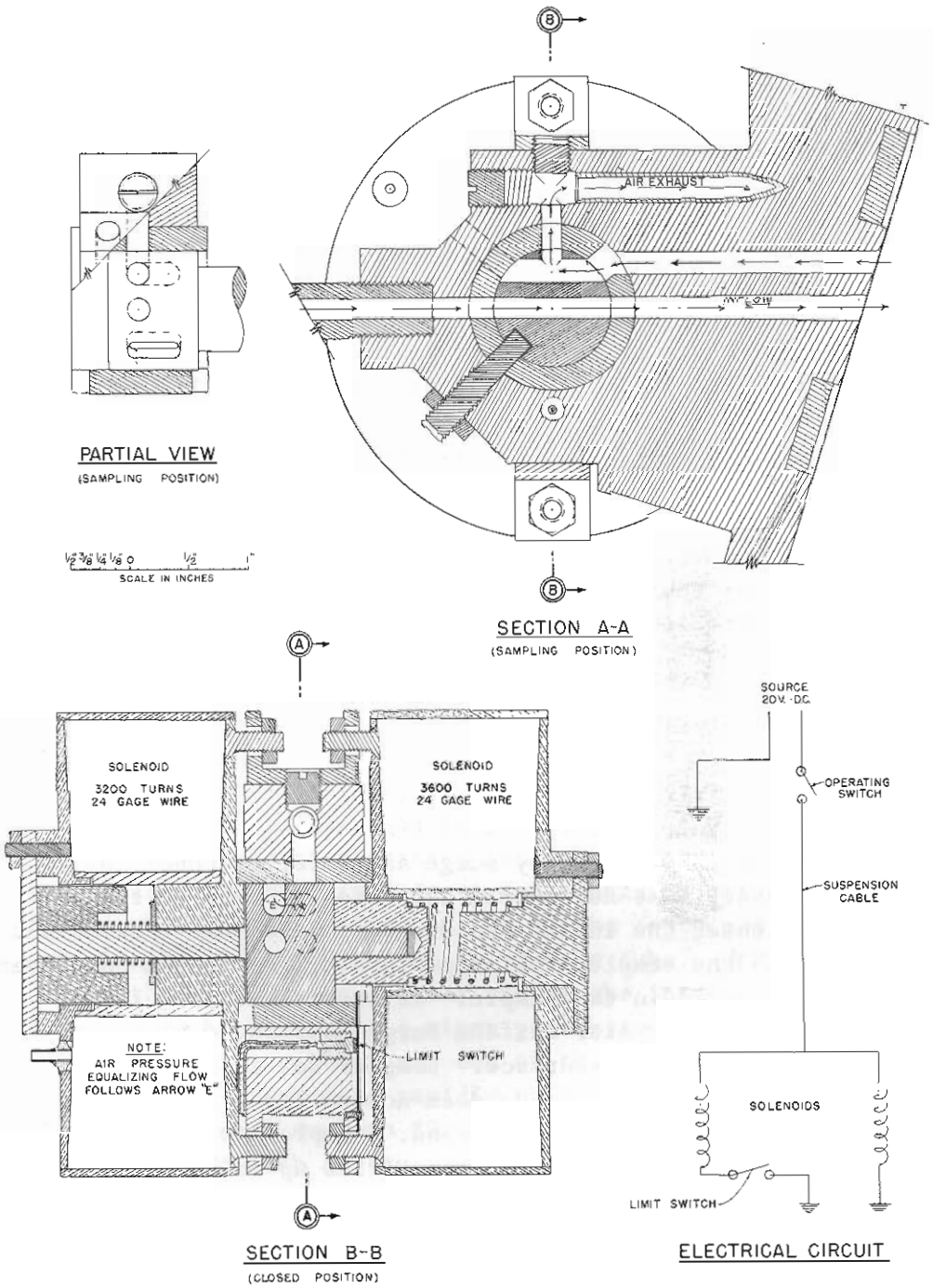


FIG. 17. POINT-INTEGRATING SUSPENDED-SEDIMENT SAMPLER, USP-50, VALVE MECHANISM

6. Automatic single-stage suspended-sediment sampler

This sampler is used for automatic collection of samples from flashy, intermittent streams at remote or not easily accessible sites, which are visited by personnel at infrequent intervals. The sampler is in the development stage and present models are not standardized.

The sampler consists of a pint milk bottle or other sample container, a 3/16-inch inside diameter copper tube air exhaust, and a 3/16-inch or 1/4-inch inside diameter copper tube intake, each tube bent to an appropriate shape and inserted through a stopper which fits tightly into the top of the container. There are two general types of automatic samplers, one with a vertical intake and the other with a horizontal intake. Under some conditions either type could be used but the two are not always interchangeable. Examples of samplers are shown in Figs. 18 and 19.

The vertical intake sampler should be used only to sample suspended sediments finer than 62 microns. It is less subject to collection of debris and deposits of sediment in the intake nozzle than the horizontal type of intake.

The horizontal intake sampler is used for sampling suspended sediments coarser than 62 microns. The intake is only approximately horizontal--generally it is inclined slightly downward to prevent the accumulation of sediment in the outer end of the intake. The height of intake and exhaust tubes is dictated by surge and velocity conditions. If the exhaust tube invert does not exceed the velocity head at the time of sampling, flow may enter the intake and discharge from the exhaust and the circulation through the sampler will deposit sediment in the container in addition to that properly in the sample. If the intake tube invert does not exceed the height of water-surface surge sampling will occur intermittently and from the water-surface. Sampler No. 2, Fig. 19, should be used where water-surface surge does not exceed 2 1/2 inches and the velocity does not exceed 4 feet per second. Sampler No. 10 can operate in surges up to 5 or 6 inches and velocities up to 7 feet per second. The heights of intake and air exhaust inverts should be increased for greater water-surface surges or larger stream velocities.

Several sampling units may be securely mounted, one above another, on a vertical support so that a sample is obtained as each of several known water-surface elevations are reached by a rising stage.

Normal sampling operation is as follows: As the water surface rises in the stream it also rises in the intake tube of the sampler.

When water reaches the crown of the intake, flow starts over the crown, primes the siphon and begins to fill the bottle. Sampling ceases when the water level in the bottle reaches the inner end of the air exhaust. The air-lock in the air exhaust then prevents circulation through the sampler. An air-lock also forms in the intake and prevents enrichment of the sample from water surging back and forth in the intake and transporting sediment into the sample container.

These samplers have several limitations which make them less accurate than personally attended and operated samplers. They are designed primarily for use where adequate sampling by other means would be impracticable. For stream velocities up to at least eight feet per second automatic samplers can obtain samples that are accurate to within ten per cent of the sediment concentration at the sampling point. In many instances the relation of the concentration at the sampling point to that in the stream is not known as closely.

There are possibilities of serious errors if automatic single-stage suspended-sediment samplers are used for conditions to which they are not adapted. However, if the samplers are properly designed for a given set of sampling conditions serious errors can be almost entirely eliminated.

If the depth of submergence of the sample bottle increases after the sample has been taken, the air in the bottle is compressed and a small additional flow enters the bottle. Under variable submergence caused by a sequence of rising and falling stages the added water compresses air on rising stages and expanding air escapes on falling stages, thus, the quantity of air in the container becomes less and water may rise to the inner end of the intake tube. Until the added water raises the sample to the inner end of the intake, the original sample is not altered by more than a minor percentage of the original concentration of sediment. Once the inner end of the intake is immersed in the sample, surges in the intake can rapidly enrich the sample. At least three submergence cycles from 0 to 20 feet are required to fill the container to that level and such a sequence of submergences would be extremely rare.

Some of the advantages of the automatic single-stage sampler are:

Personnel need not be present at the time of sampling.
Samples may be obtained at predetermined stages of the stream.
Sampling apparatus is simple and inexpensive.

Some of the limitations of the single-stage sampler are:

Samples are taken at or near the surface of the stream.
Samples will usually be obtained near the edge of the stream.
Intake velocities are not always equal to stream velocities.
No samples are taken on the falling stage of the stream.
The original sample may be altered by subsequent submergence.
No one sampler design is best for all stream conditions.

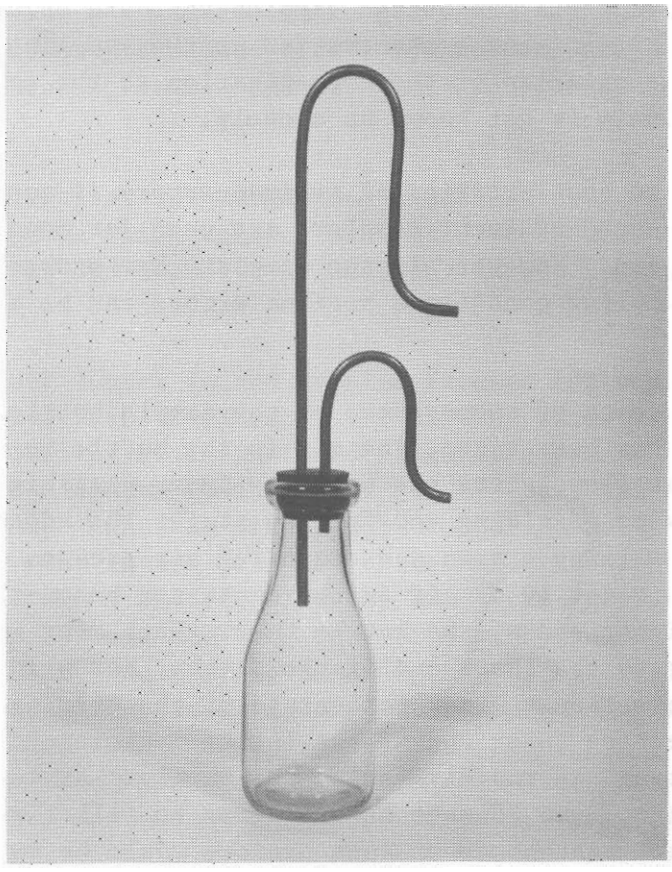
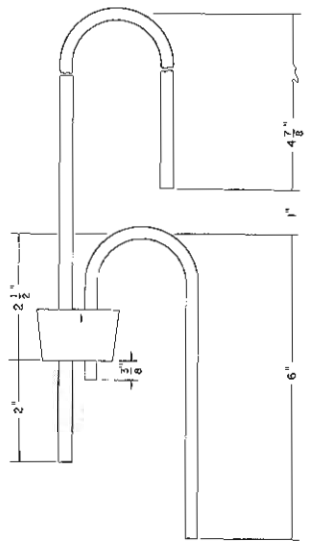
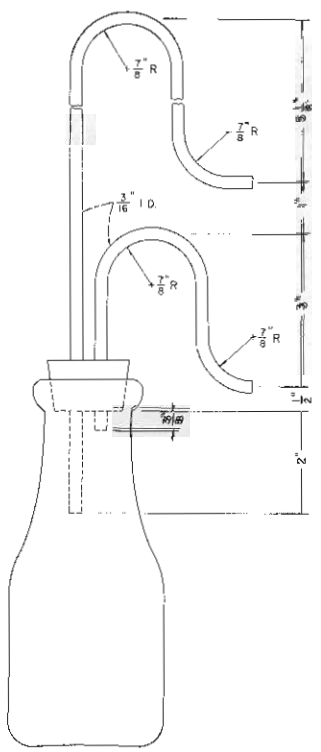


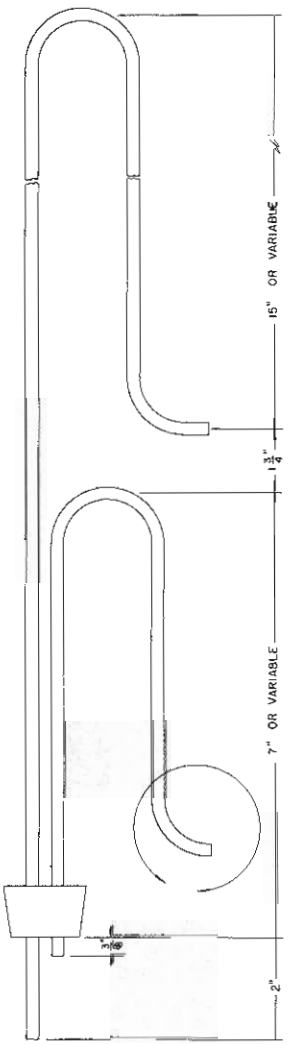
Fig. 18 Automatic single-stage suspended-sediment sampler



VERTICAL INTAKE



HORIZONTAL INTAKE
SAMPLER NO. 2



SAMPLER NO. 10

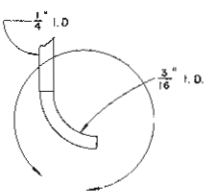


FIG. 19. AUTOMATIC SINGLE-STAGE SUSPENDED-SEDIMENT SAMPLER

7. Piston-type bed-material hand sampler, US BMH-53

This sampler is used to collect a sample from the bed of a shallow stream which may be waded.

The sampler contains a cylinder 2 inches in diameter and 8 inches long which is pressed into the stream bed to collect the sample. A piston is located inside the cylinder. The overall length of the sampler is 46 inches. A handle for pressing the cylinder into the bed is located at the top of the sampler frame. The piston rod with a handle on its upper end passes through the sampler frame. The piston is retracted when the cylinder is pressed into the bed material. The suction created by the piston holds the sample in the cylinder. The sample is pushed out of the cylinder by the piston. The sampler is shown in Figs. 20 and 21.

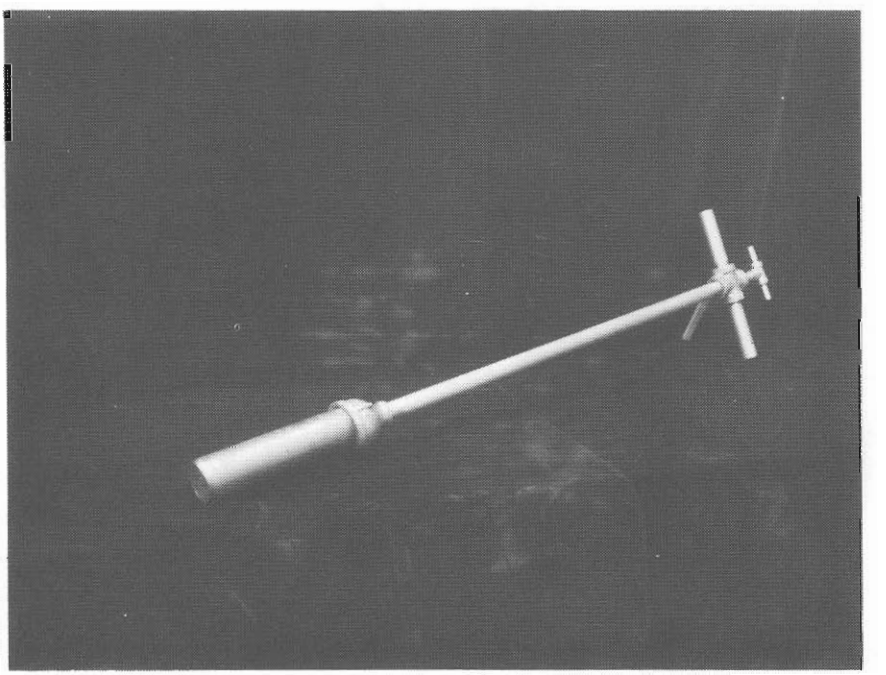


Fig. 20 Piston-type bed-material hand sampler, US BMH-53

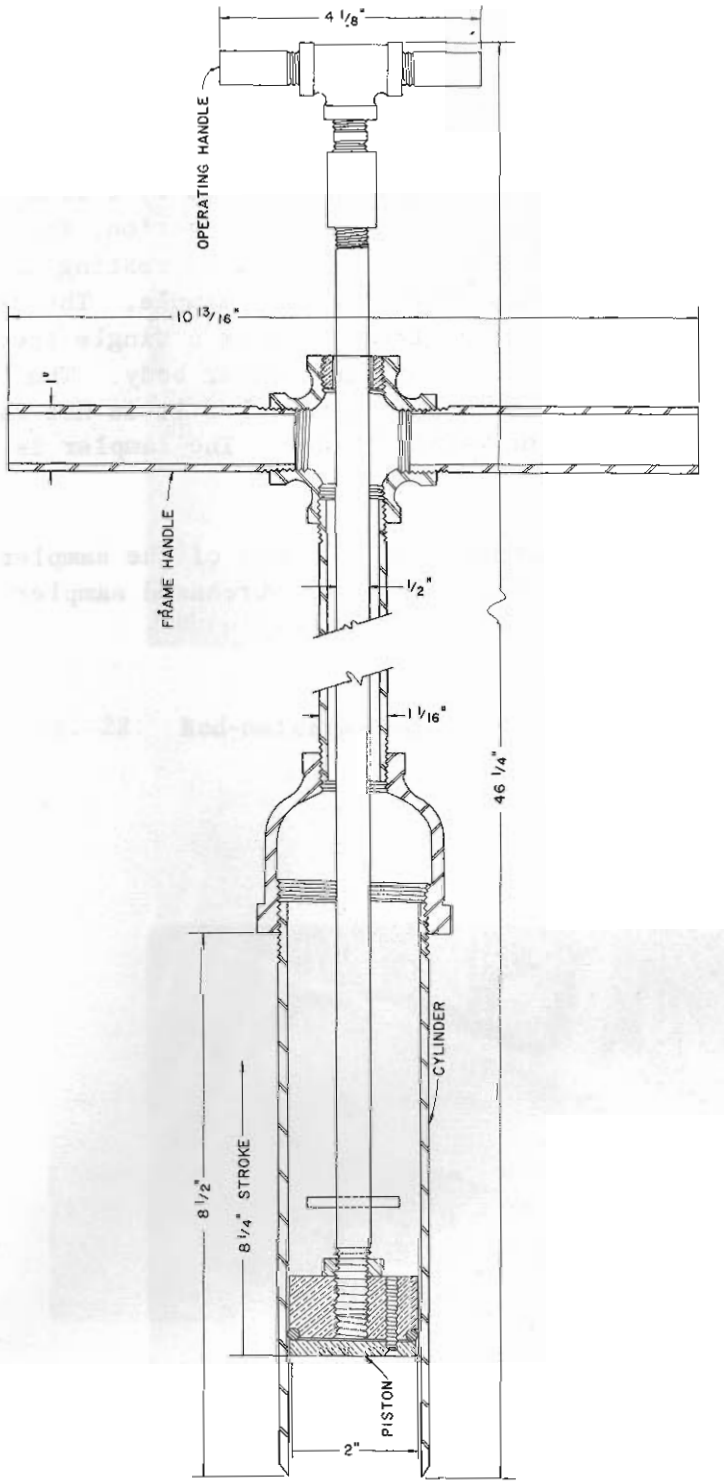


FIG. 21. PISTON-TYPE BED-MATERIAL HAND SAMPLER USBMH-53

8. Bed-material sampler, US BM-54

This is a 100-pound sampler used to collect samples from the bed of a stream or reservoir of any depth.

The sampler is made of cast steel, is equipped with tail fins, and is 22 inches long. When the sampler is supported by a steel cable the bucket may be cocked, that is set in the open position, for taking a bed sample. When tension on the cable is released by resting the sampler on the stream bed, the bucket snaps shut taking a sample. The sample is collected from the top 2 inches of a stream bed, in a single scoop-type bucket which swings out of the bottom of the sampler body. The bucket surrounds and encloses the sample in such a way that it is not washed out when the sampler is raised to the water surface. The sampler is shown in Figs. 22, 23, and 24.

Information on operation and maintenance of the sampler is found in Report M which is furnished with each purchased sampler.

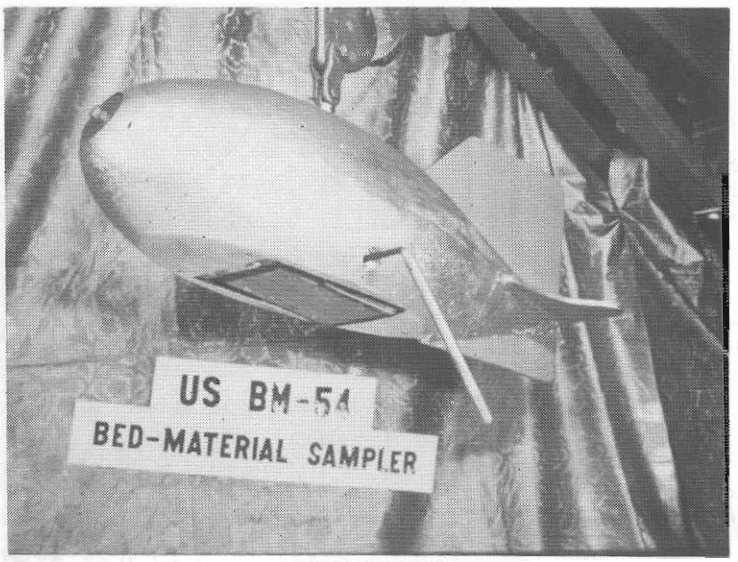


Fig. 22 Bed-material sampler, US BM-54, bucket retracted

Fig. 23 Bed-material sampler, US BM-54, bucket exposed

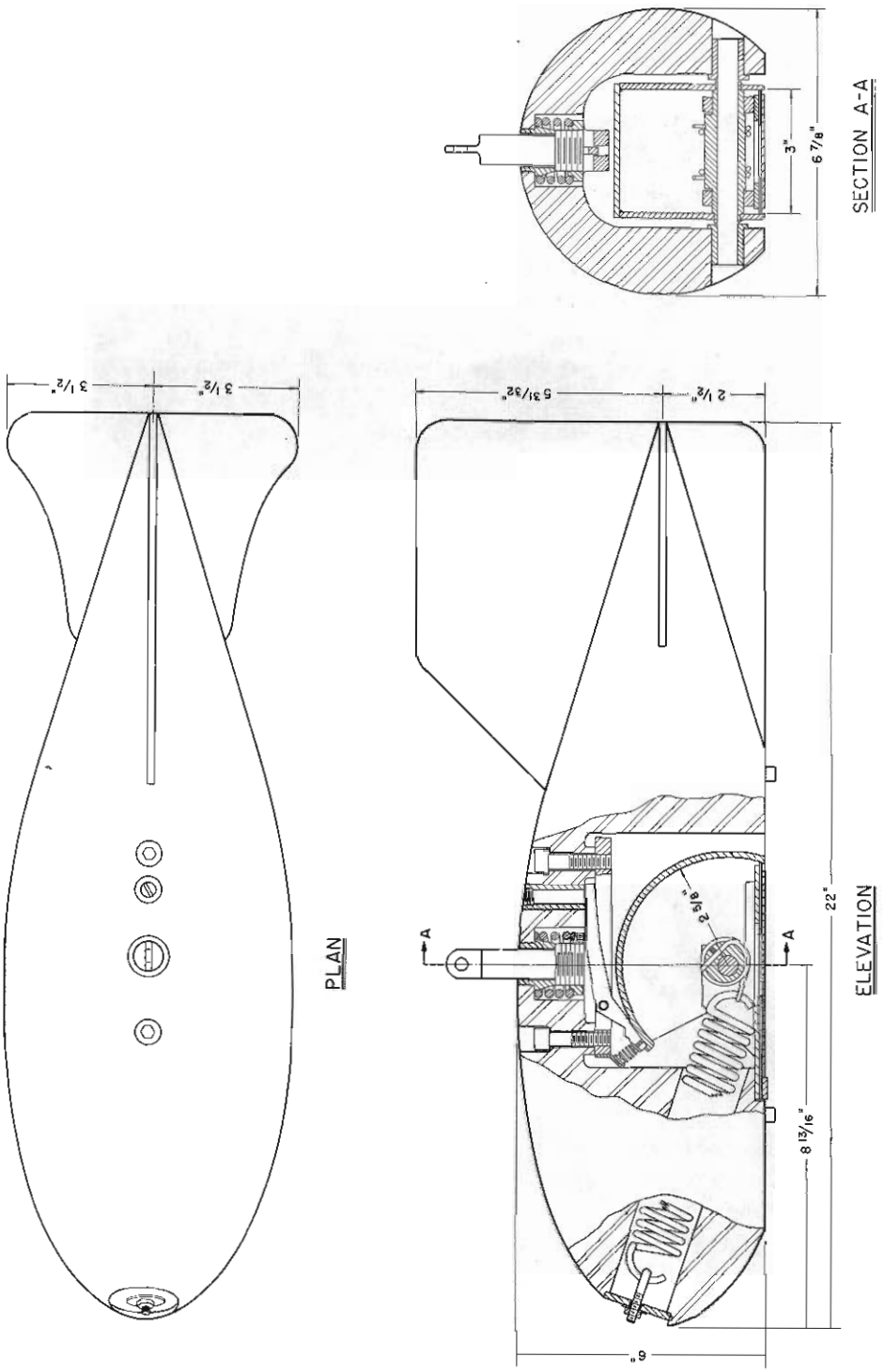


FIG. 24. BED-MATERIAL SAMPLER USBM-54

9. Visual-accumulation-tube sand size analyzer

This is a laboratory instrument for the simple and rapid determination of the size frequency distribution of sand samples containing particles from 62 microns to 2 millimeters. The instrument records results in terms of the fall velocity of the individual particles of the sample.

The analyzer consists of a glass sedimentation tube, a valve mechanism and a recorder (see Figs. 25 and 26). The lower end of the glass sedimentation tube is reduced in diameter to facilitate measurement of accumulated sediment. Tubes 120 cm long are furnished in 4 sizes with the lower end reduced to 2.1, 3.4, 5.0, and 7.0 mm inside diameter respectively. These tubes are for analyzing sands up to 1 mm in size. Two of each of these 4 sizes are furnished with the analyzer. A tube 180 cm long may also be used for analysis of sands up to 2 mm in size. Selection of the tube to be used is based on the quantity and size of material available in the sample to be analyzed. The 180 cm tube and accessories are not furnished as part of the analyzer because the tube is difficult to pack so that it will not be broken in shipment. It is more satisfactory to have this tube made locally. The accessories for the 180 cm tube may be obtained on special order.

To make an analysis the sample is introduced into the top of the tube. The particles are separated in size as they fall through the water in the tube. As the sediment accumulates in the settling section of the tube, the height of the column is followed manually and a grain size curve is automatically and simultaneously traced on a chart. The per cent finer of each particle size classification in the sample analyzed may be read from this graph. A sample of the size distribution graph showing the method of reading size distribution in per cent is shown in Fig. 27.

A supply of 200 charts and a tracing from which charts may be made are furnished with the analyzer.

Additional information on the visual-accumulation-tube sand size analyzer is given in Report No. 11 and Reports K and L. Report K is furnished with each analyzer.

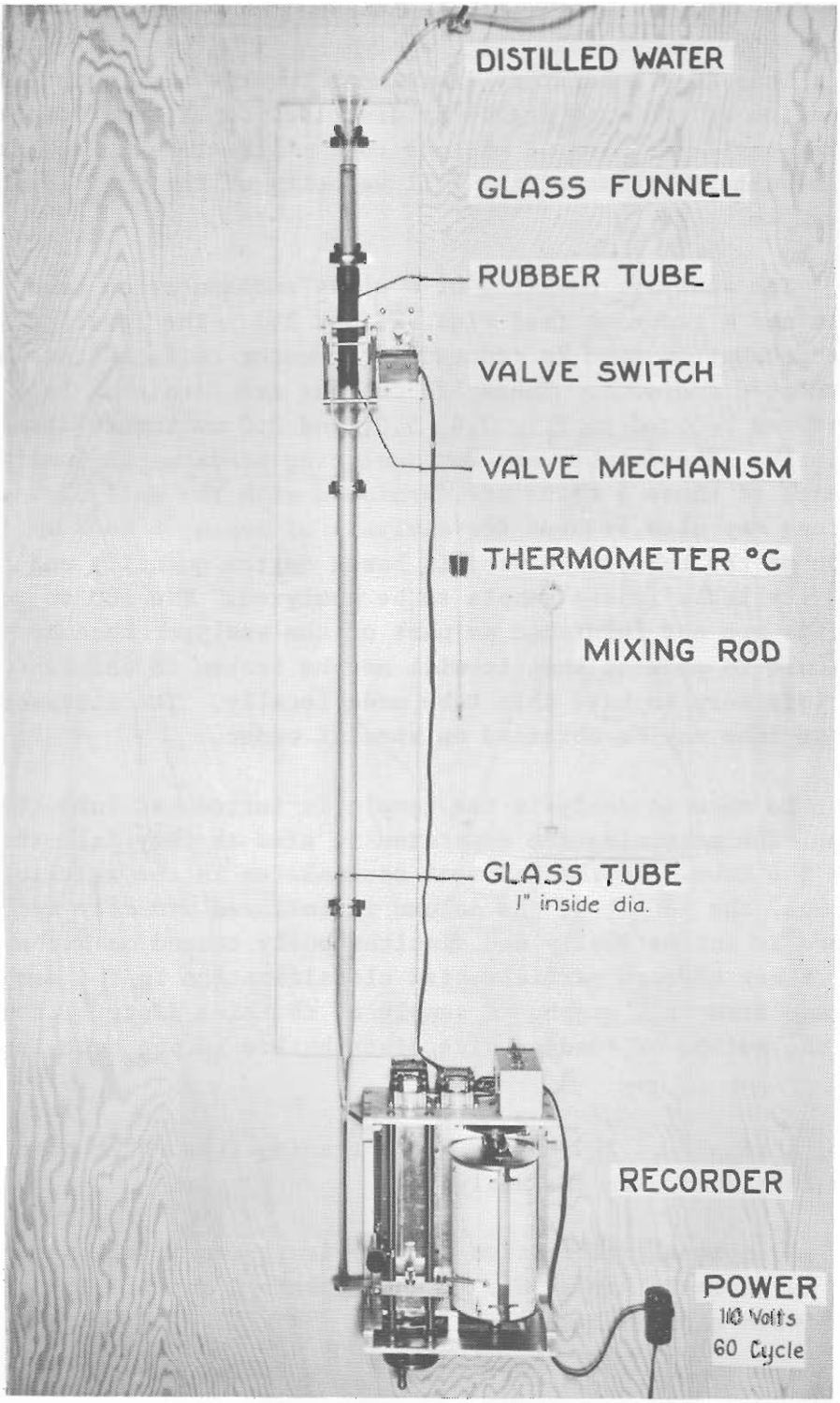


Fig. 25 Visual-accumulation-tube sand size analyzer

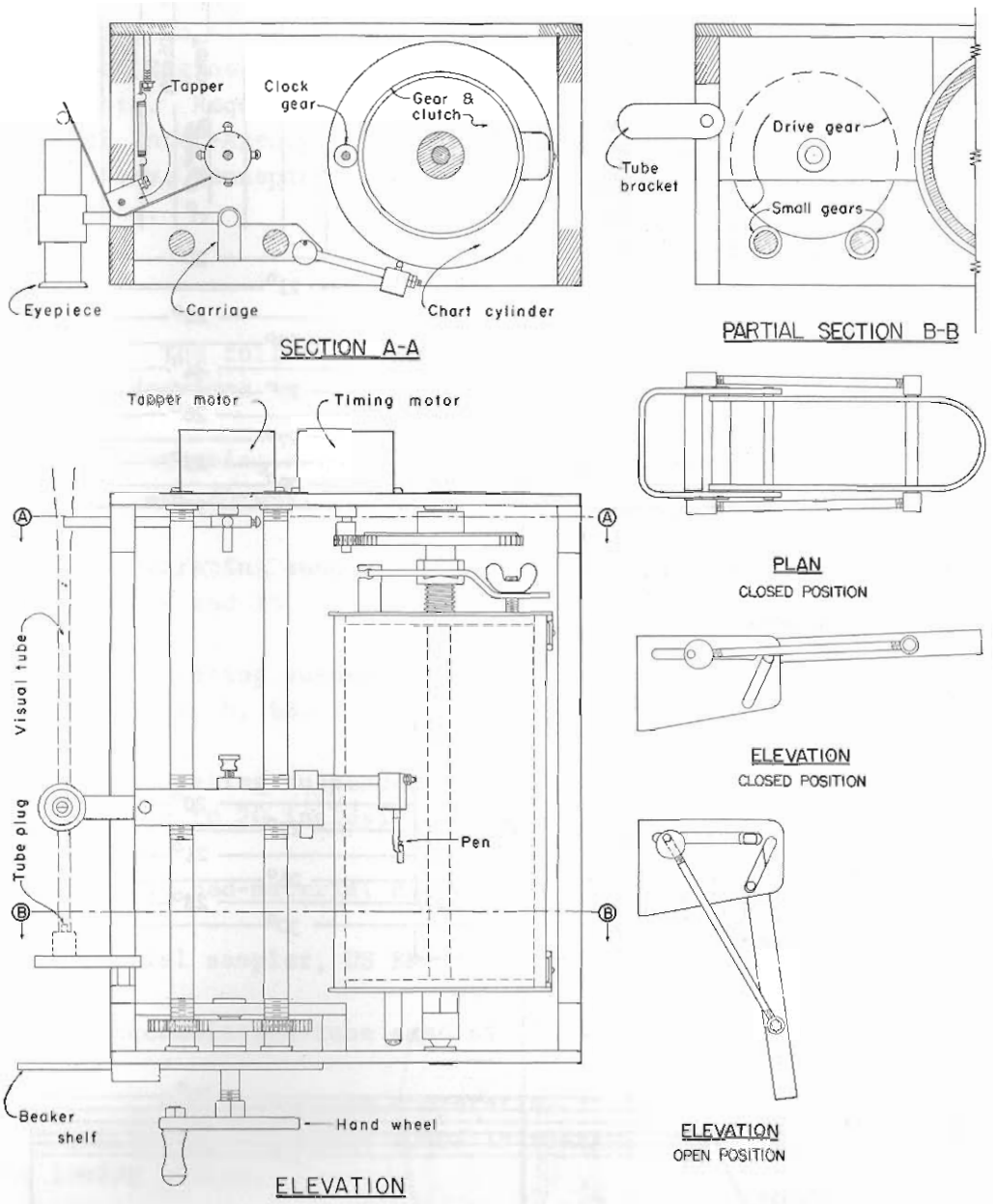


FIG. 26. VISUAL-ACCUMULATION-TUBE SAND SIZE ANALYZER, RECORDER AND VALVE MECHANISM

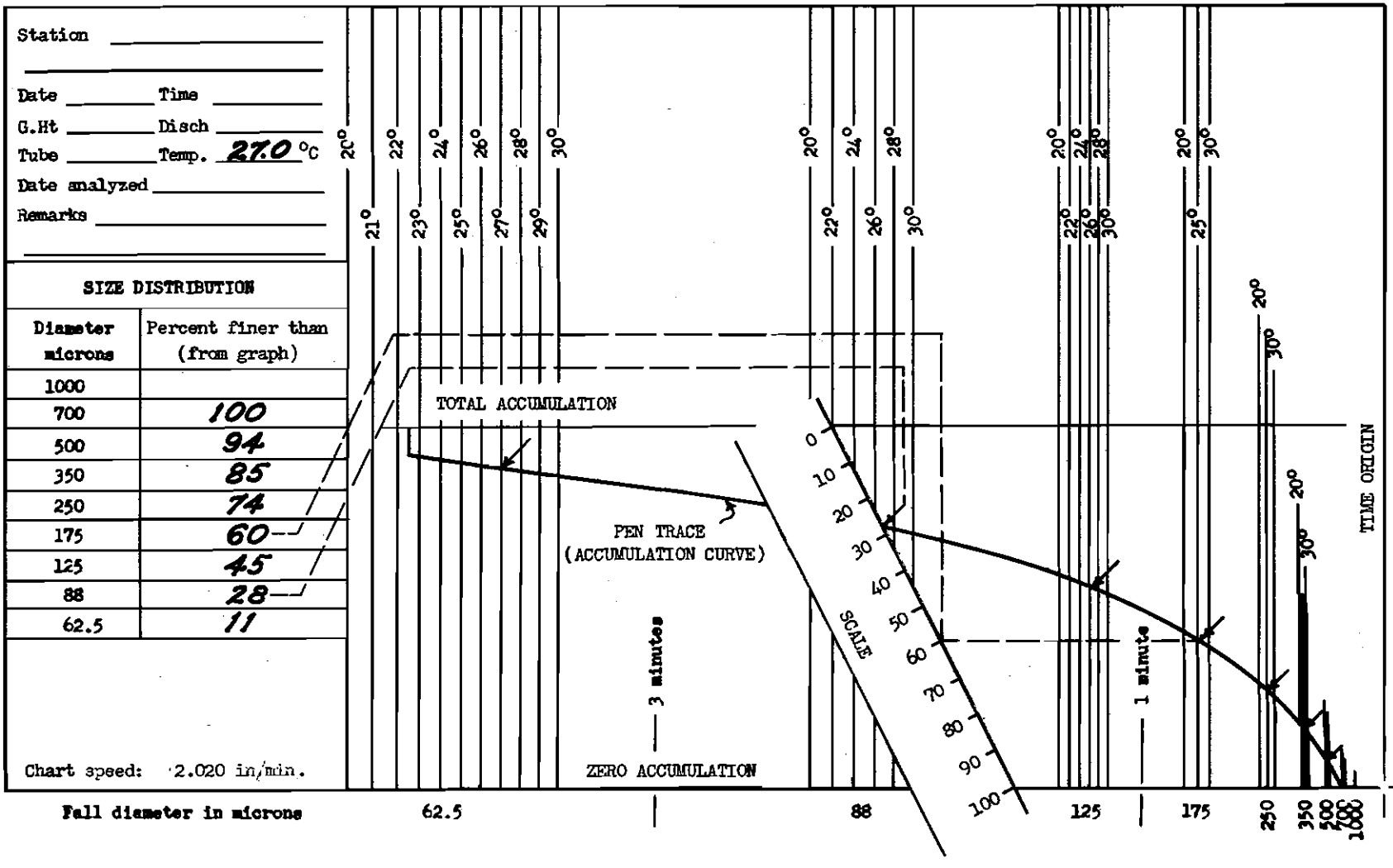


FIG. 27 — VISUAL-ACCUMULATION-TUBE SAND SIZE ANALYZER. RECORDER CHART FOR 120 CM TUBE SHOWING METHOD OF READING SIZE DISTRIBUTION

10. Construction drawings and reports

Requests for construction drawings and numbered reports may be addressed to District Engineer, U. S. Army Engineer District, St. Paul, Corps of Engineers, 1217 U. S. Post Office and Custom House, St. Paul 1, Minnesota. Requests for lettered reports may be addressed to the Federal Inter-Agency Sedimentation Project, St. Anthony Falls Hydraulic Laboratory, Hennepin Island and Third Avenue S. E., Minneapolis 14, Minnesota.

Construction Drawings

The following construction drawings are available. The price of most drawings is 55 cents per sheet.

Depth-integrating suspended-sediment wading-type hand sampler, US DH-48, 1 sheet, No. Z6-6-9.

Depth-integrating suspended-sediment sampler, US D-49, 2 sheets, No. Z6-6-14 and 15.

Point-integrating suspended-sediment sampler, US P-46, 8 sheets, No. Z6-6-3 to 6, 6B, 7, 7B, and 8 inclusive.

Point-integrating suspended-sediment sampler, US P-50, 5 sheets, No. Z6-6-16 to 20 inclusive.

Piston-type bed-material hand sampler, US BMH-53, 1 sheet.

Bed-material sampler, US BM-54, 3 sheets, Z6-6-21 to 23 inclusive.

Visual-accumulation-tube sand size analyzer, 7 sheets.

Reports on the cooperative study of methods used in MEASUREMENT AND ANALYSIS OF SEDIMENT LOADS IN STREAMS covers phases indicated by the following titles.

Numbered Reports

Report No. 1 FIELD PRACTICE AND EQUIPMENT USED IN SAMPLING SUSPENDED SEDIMENT $1.50

Report No. 2** EQUIPMENT USED FOR SAMPLING BED LOAD AND BED MATERIAL $0.75

Report No. 3 ANALYTICAL STUDY OF METHODS OF SAMPLING SUSPENDED SEDIMENT $0.75

Report No. 4	METHODS OF ANALYZING SEDIMENT SAMPLES	2.00 ~~$1.50~~
Report No. 5	LABORATORY INVESTIGATIONS OF SUSPENDED-SEDIMENT SAMPLERS	$0.75
Report No. 6	THE DESIGN OF IMPROVED TYPES OF SUSPENDED-SEDIMENT SAMPLERS	$1.50
Report No. 7	A STUDY OF NEW METHODS FOR SIZE ANALYSIS OF SUSPENDED-SEDIMENT SAMPLES	1.00 ~~$0.75~~
Report No. 8 **	MEASUREMENT OF THE SEDIMENT DISCHARGE OF STREAMS	$0.75
Report No. 9 **	DENSITY OF SEDIMENTS DEPOSITED IN RESERVOIRS	$0.75
Report No. 10	ACCURACY OF SEDIMENT SIZE ANALYSIS MADE BY THE BOTTOM-WITHDRAWAL-TUBE METHOD	$1.50
Report No. 11	THE DEVELOPMENT AND CALIBRATION OF THE VISUAL-ACCUMULATION TUBE	$1.00
Report No. 12	SOME FUNDAMENTALS OF PARTICLE-SIZE ANALYSIS From Government Printing Office, Washington, D. C.	$0.35
Report No. 13	THE SINGLE-STAGE SAMPLER FOR SUSPENDED SEDIMENT (Also from Government Printing Office, Washington, D.C.)	$0.~~50~~55

Lettered Reports

Report AA	FEDERAL INTER-AGENCY SEDIMENTATION INSTRUMENTS AND REPORTS	MAY 1959 $1.00
Report A **	PRELIMINARY FIELD TESTS OF THE U. S. SEDIMENT-SAMPLING EQUIPMENT IN THE COLORADO RIVER BASIN	APRIL 1944
Report B **	FIELD CONFERENCES ON SUSPENDED-SEDIMENT SAMPLING	SEPTEMBER 1944
Report C **	COMPARATIVE FIELD TESTS ON SUSPENDED-SEDIMENT SAMPLERS PROGRESS REPORT	DECEMBER 1944
Report D **	COMPARATIVE FIELD TESTS ON SUSPENDED-SEDIMENT SAMPLERS PROGRESS REPORT	AS OF JANUARY 1946

Report E ** STUDY OF METHODS USED IN MEASUREMENT AND ANALYSIS OF SEDIMENT LOADS IN STREAMS (See Transactions ASCE Vol. 116, 1951) JULY 1946

Report F FIELD TESTS ON SUSPENDED-SEDIMENT SAMPLERS, COLORADO RIVER AT BRIGHT ANGEL CREEK NEAR GRAND CANYON, ARIZONA AUGUST 1951 $1.00

Report G ** PRELIMINARY REPORT ON U. S. DH-45 (HAND) SUSPENDED-SEDIMENT SAMPLER

Report 14 DETERMINATION OF FLUVIAL SEDIMENT DISCHARGE DECEMBER 1963 $0.70

Report L *** VISUAL-ACCUMULATION TUBE FOR SIZE ANALYSIS OF SANDS, Jour. Hydr. Div., ASCE, Vol. 82, No. HY3, Paper No. 1004 JUNE 1956

Report Q INVESTIGATION OF A PUMPING SAMPLER WITH ALTERNATE SUSPENDED-SEDIMENT HANDLING SYSTEMS JUNE 1962 $0.75

Report R ELECTRONIC SENSING OF SEDIMENT (~~In Preparation~~) Progress Report Dec. 1964 $0.75

Report S A SUMMARY OF THE WORK OF THE FEDERAL INTER-AGENCY SEDIMENTATION PROJECT JANUARY 1963 $0.35

Report K OPERATOR'S MANUAL, THE VISUAL-ACCUMULATION-TUBE METHOD FOR SEDIMENTATION ANALYSIS OF SANDS REVISION OCTOBER 1958 $0.75

Report L VISUAL-ACCUMULATION TUBE FOR SIZE ANALYSIS OF SANDS SEPTEMBER 1954 (Paper presented at ASCE convention, Austin, Texas) Free

Report M OPERATION AND MAINTENANCE OF U. S. BM-54 BED-MATERIAL SAMPLER NOVEMBER 1958 $0.50

Report N INTERMITTENT PUMPING-TYPE SAMPLER PROGRESS REPORT FEBRUARY 1960 $0.50

Report O INSTRUCTIONS FOR SAMPLING WITH US D-49 SUSPENDED SEDIMENT SAMPLER MARCH 1960 $0.25

Report P INVESTIGATIONS OF DIFFERENTIAL-PRESSURE GAGES FOR MEASURING SUSPENDED-SEDIMENT CONCENTRATIONS JUNE 1960 $0.50

** Out of Print

11. Tentative price list of instruments

May 1969 ~~1965~~

The prices of instruments shown below are based on ~~1958~~ costs and are subject to change without notice. Prices are f.o.b. Minneapolis, Minnesota, and apply only to purchases for Federal Agencies.

Depth-integrating suspended-sediment wading-type hand sampler, US DH-48	OK 11-5-69 → 44.00 ~~39.50~~ ~~35~~ ~~40~~ 5-31-72 → $280 ~~$237.00~~ ~~270~~
Depth-integrating suspended-sediment sampler, US D-49	$ ~~255.~~
Point-integrating suspended-sediment sampler, US P-46	$ 865 ~~720.~~
Point-integrating suspended-sediment sampler, US P-50	2,650 ~~$3,000.~~
Automatic single-stage suspended-sediment sampler	~~$3.~~ 4.50 to ~~$6.~~ 9.00
Piston-type bed-material hand sampler, US BMH-53	$ 90 ~~75.~~
Bed-material sampler, US BM-54	$ 375 ~~410.~~
Visual-accumulation-tube sand size analyzer	$ 725 ~~640.~~

Replacements for the 120 cm sedimentation tube cost about $11. each in lots of 2 or more.

Depth-integrating hand-line suspended-sediment sampler, US DH-59	OK Nov. 5, 1969 → $127.50 ~~100~~ ~~$90.~~
Hand-line bed-material sampler, US BMH-60	~~300~~ ~~$330.~~
Point-integrating suspended-sediment sampler, US P-61	625 ~~$550.~~
Point-integrating suspended-sediment sampler, US P-63	880 ~~$750.~~

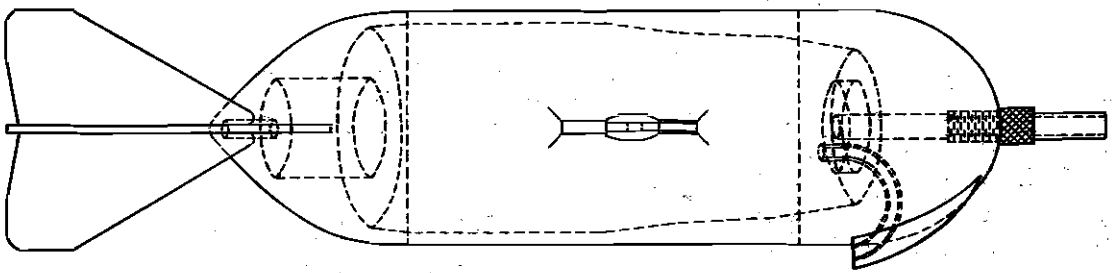
These prices are ~~not~~ current in 1965.

12. Depth-integrating hand-line suspended-sediment sampler, US DH-59

This is a medium-weight suspended-sediment sampler for attachment to a hand-line type of suspension. The sampler can be lowered and raised by hand power with a flexible suspension line and hand over hand operation.

This sampler comprises a stream-lined bronze casting, 15 inches long, which partially encloses a round pint-size glass milk bottle. This sampler weighs approximately 22-pounds and is equipped with a tail vane assembly to orient the intake nozzle of the sampler into the approaching flow as the sampler enters the water. The glass-bottle sample container is sealed against a gasket in the head cavity of the casting by pressure applied to the base of the bottle by a hand-operated spring-tensioned pull-rod assembly at the tail of the sampler. Suspended-sediment samples, collected by the intake nozzle projecting horizontally upstream from the head of the casting, are discharged into the milk bottle containers. The air in the milk bottle which is being displaced by the accumulated sample is ejected downstream through an air exhaust tube cast integrally with the body casting and protected by a streamlined projection alongside the head of the sampler. The sampler is calibrated and supplied with nozzles having 1/4-inch, 3/16-inch and 1/8-inch bore. Sample container bottles and the suspension are not furnished with the hand-line suspended-sediment sampler.

In operation, a clean bottle for each sample is securely sealed within the body of the sampler. The appropriate nozzle is selected and seated in the threaded recess of the sampler head, and the sampler lowered and raised at a uniform rate between the water surface and the bottom of the stream. On contacting the stream bed the direction of travel is reversed instantly and the sampler raised at the same or some other uniform rate. This sampler continues to take its sample throughout the period of submergence and must be removed from the stream before the bottle has completely filled. Bottled samples are carefully removed from the sampler, properly capped and marked, and shipped to the laboratory for analysis.



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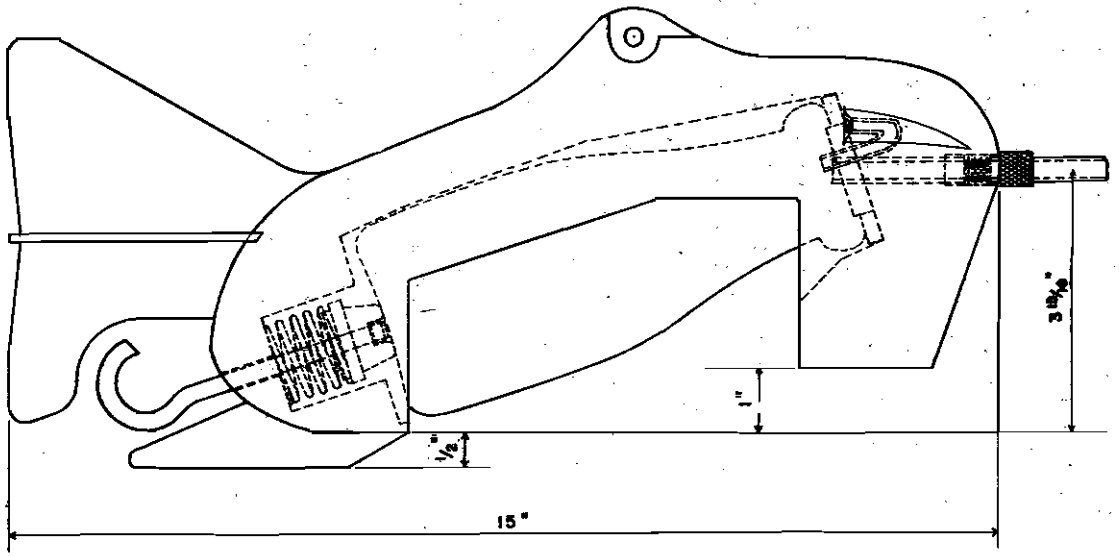
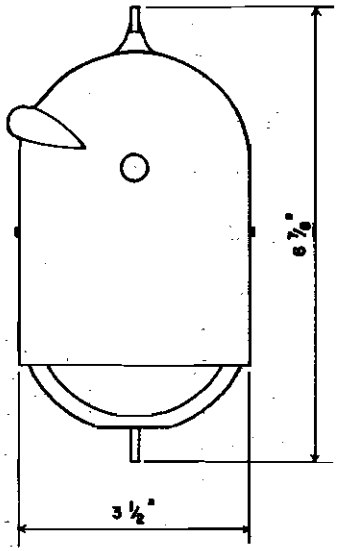


ELEVATION



FRONT

SUSPENDED-SEDIMENT SAMPLER, U.S. DH-59

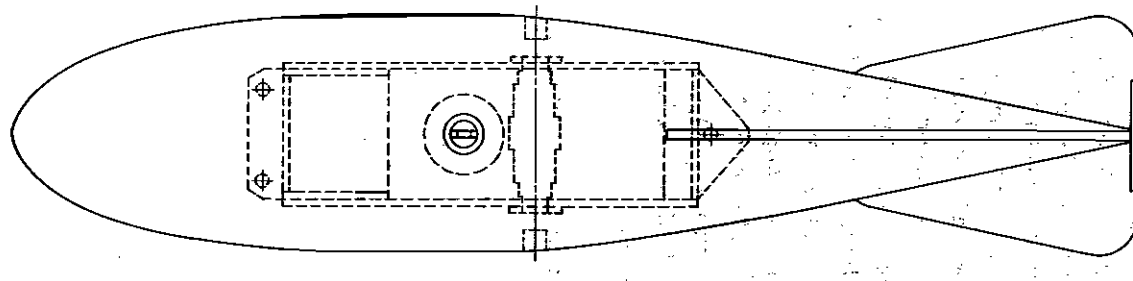
HAND LINE SUSPENSION

13. Hand-line bed-material sampler, US BMH-60

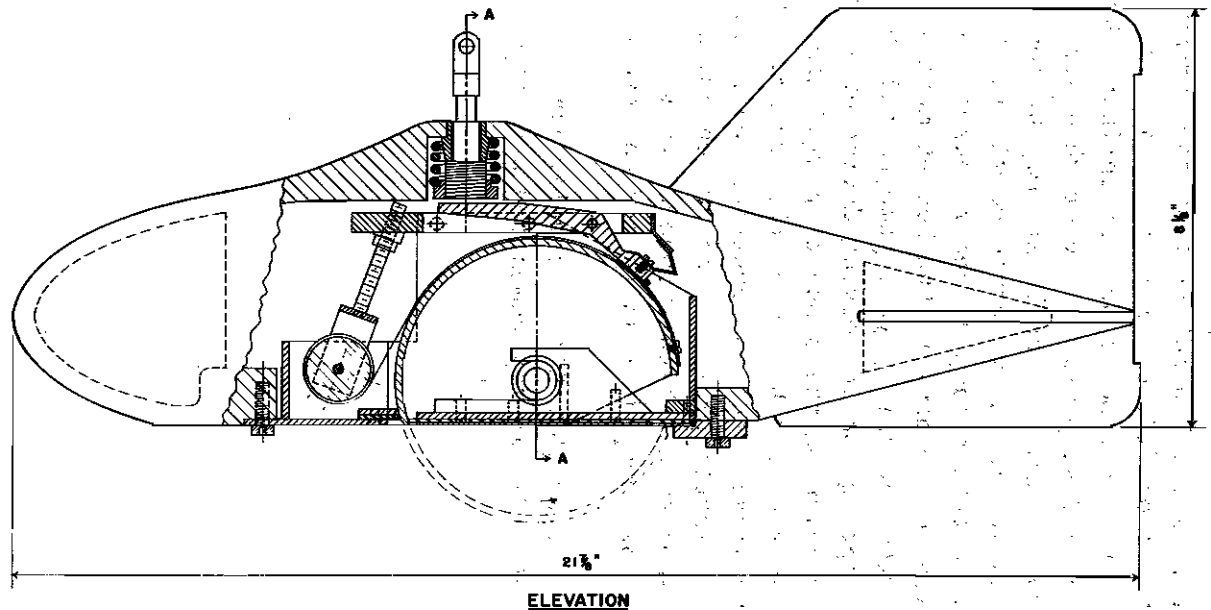
This is a 30-pound sampler used to collect samples from the bed of a stream, lake, or a reservoir. Penetration of the bed material is approximately 1.75-inches. The sampler can be suspended from a flexible line and lowered and raised by hand power.

The body of the sampler is made of aluminum, is equipped with tail vanes and is approximately 22-inches long. Ballast has been placed within the body of the sampler to control its weight. This sampler is nose heavy by about four pounds to assist the sampling bucket mechanism in penetrating the bed material of the stream. The sampling bucket accomodates about 175 cc of material and is spring loaded by cross-curved constant torque motor type springs. When the sampler is supported by the hand suspension line or whenever the safety yoke is in place on the grooved hanger, the bucket may be cocked to the open position i.e. the bucket is fully retracted within the body shell of the sampler and ready to take a sample when released. As long as the safety yoke is in place on the hanger, the bucket mechanism cannot be released. However, with the safety yoke removed and the sampler supported by the hand line, the spring loaded cocking device will release the bucket mechanism when the tension on the supporting hand line is released, as when the sampler rests on the bottom of the stream. The bucket in closing penetrates the stream bed and completely encloses a sample of the bed material. Gaskets prevent loss or contamination of the trapped sample. When the sampler has been recovered from the stream, the bed material sample can be removed, transferred and packaged for shipment.

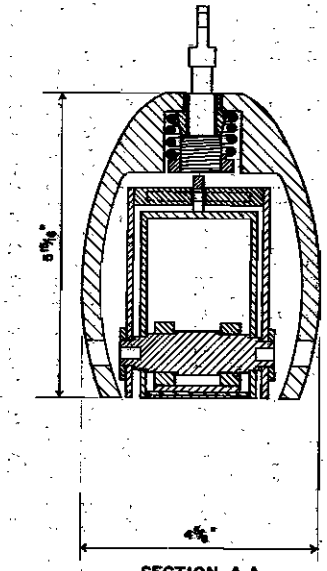
The weight of this sampler limits its use to tranquil streams and moderate or slightly compacted bed materials.



PLAN



ELEVATION



SECTION A-A

BED MATERIAL SAMPLER, U.S. BMH-60

HAND LINE SUSPENSION

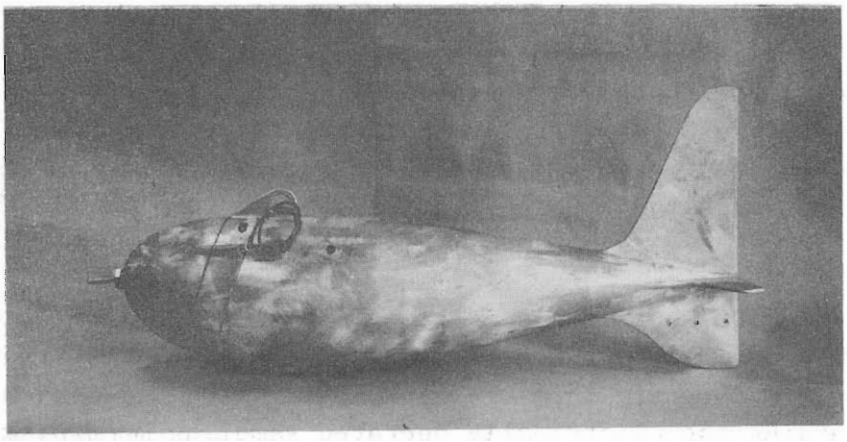
14. Point-integrating suspended-sediment sampler, US P-61

The US P-61 is a 105-pound electrically-operated suspended-sediment sampler that can be used to take a sample at a point in a stream cross section or to take a depth-integrated sample over a range of depth. The sampler is used for the same purposes and conditions as the US P-46 suspended-sediment sampler. The US P-61 is simpler, more dependable, and less expensive than the US P-46. The maximum sampling depth is about 180 feet.

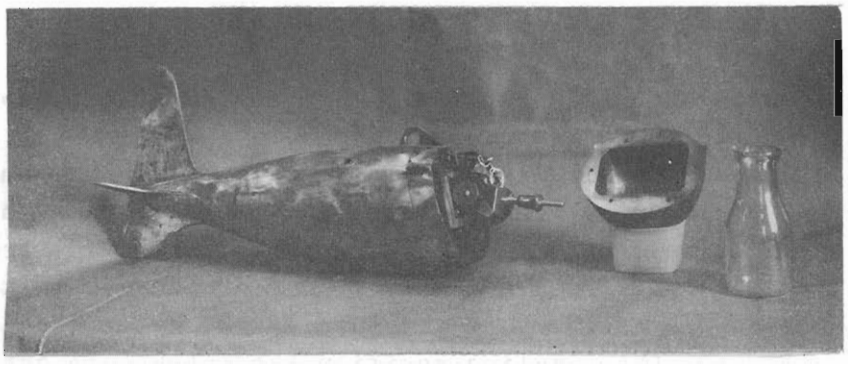
The US P-61 is a cast bronze sampler, 28 inches long. It is streamlined and has tail vanes to orient the sampler so that the intake nozzle points directly into the approaching flow. The sampler head, which contains the electrically operated sampling mechanism, is hinged to the body at the bottom. The body has a cavity for the sample container which is usually a round pint milk bottle. When the head is closed onto the body the sample container is sealed in place. There is also a pressure chamber in the body. The air in the chamber is at the static pressure corresponding to the depth of submergence.

In the US P-61, sampling is controlled by a two-position valve. The valve is held in the first position by a spring. When a rotary solenoid is actuated electrically, the valve moves into the sampling position. In the first position the intake passage from the intake nozzle to the sample container is closed and direct connection is made from the pressure chamber in the sampler body to the sample container so that the air in the sample container is at the same pressure as the water at the end of the intake nozzle. In the sampling position the intake passage is open into the sample container, the connection to the pressure chamber is closed, and the air exhaust passage is open from the sample container to the exhaust port on the side of the sampler head.

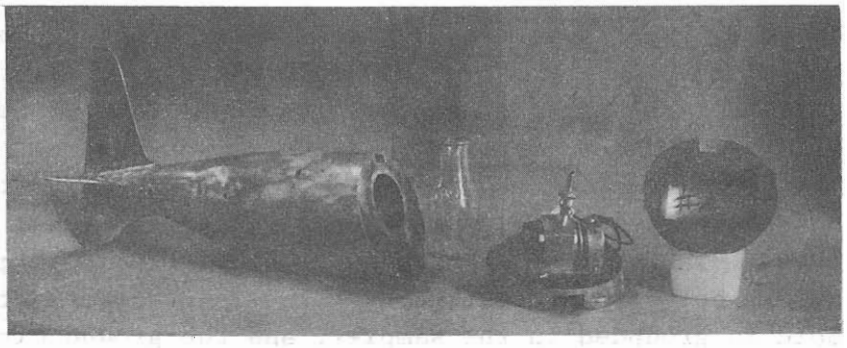
The US P-61 sampler is designed for suspension on a steel cable that has an inner conductor core that is insulated to transmit electrical energy from the operating rig to the solenoid in the sampler head. The operating current may be supplied by lantern, hot-shot, or storage batteries connected in series to produce about 48 volts of direct current. (If the suspension cable is longer than 100 feet, a higher voltage may be desirable.) The electrical circuit to the solenoid is completed by connecting one battery terminal through the inner core to the solenoid. The solenoid is grounded in the sampler, and the ground circuit is completed through the outside of the suspension cable to the opposite terminal of the battery. The sampler takes a sample while the circuit is closed. Sampling ceases when the circuit is opened.



Assembled sampler

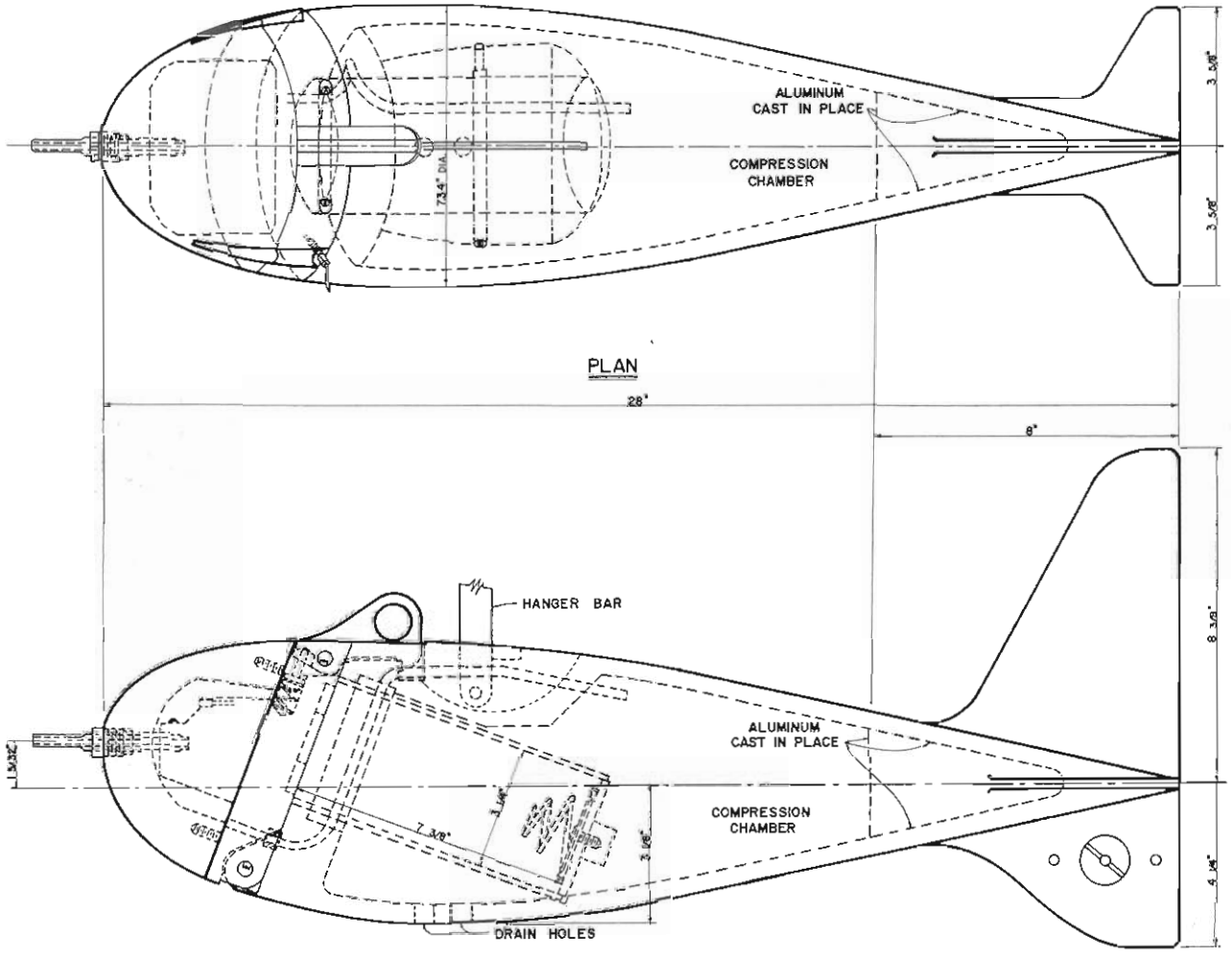


Head cover removed

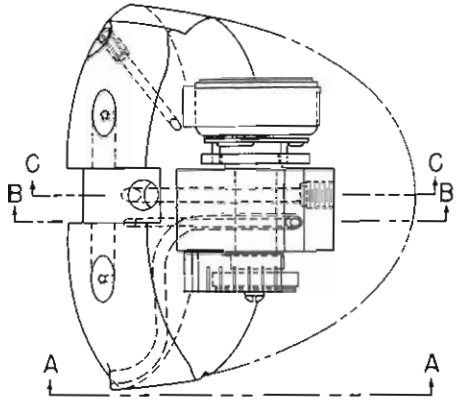


Head cover and head base removed

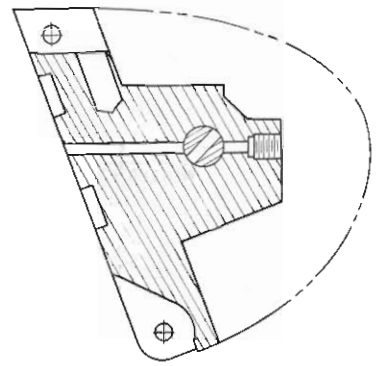
POINT-INTEGRATING SAMPLER, US P-61



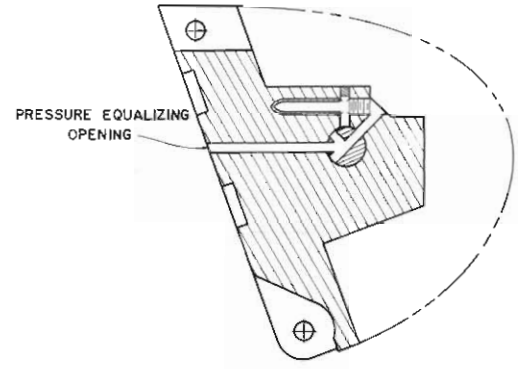
POINT-INTEGRATING SAMPLER, US P-61



PLAN

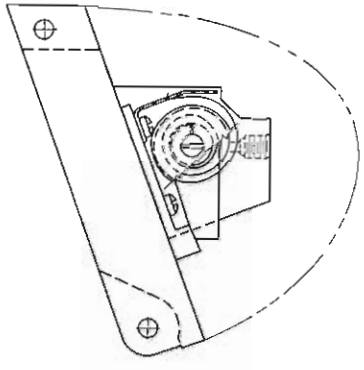


SECTION C-C

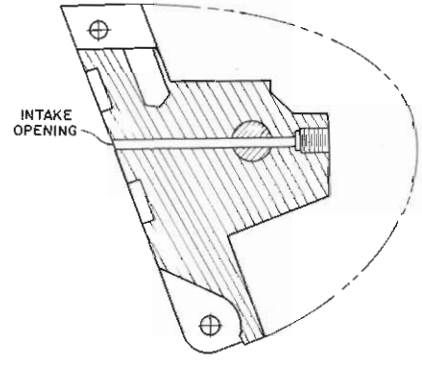


SECTION B-B

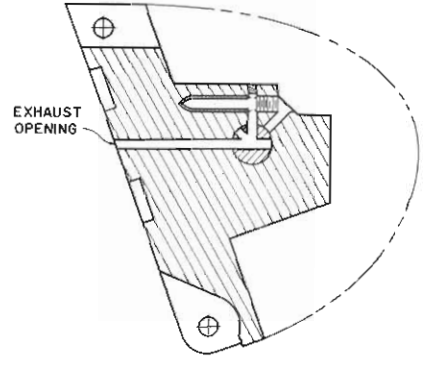
PRESSURE EQUALIZING POSITION



ELEVATION A-A



SECTION C-C



SECTION B-B

SAMPLING POSITION

POINT-INTEGRATING SAMPLER, US P-61, VALVE MECHANISM

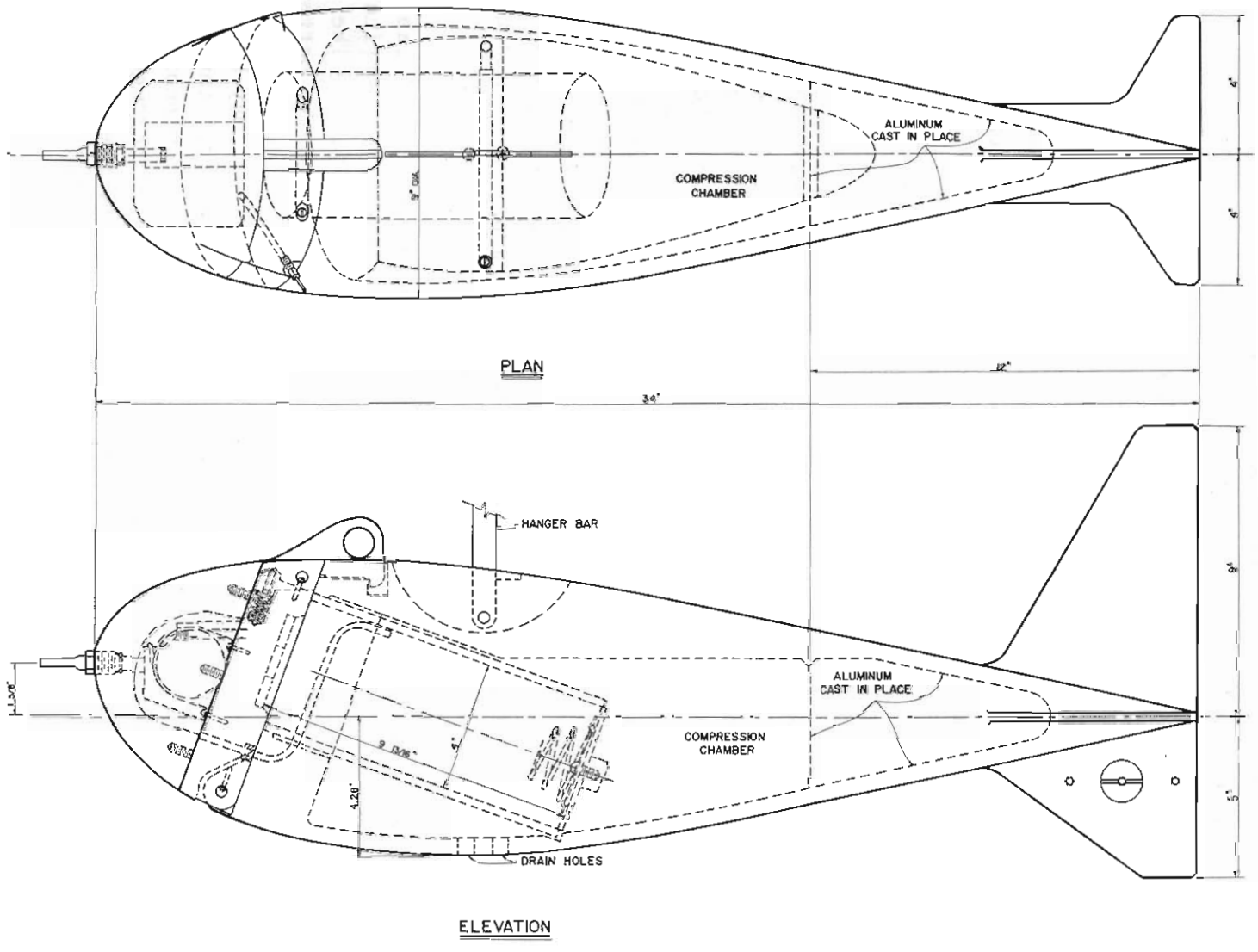
15. Point-integrating suspended-sediment sampler, US P-63

The US P-63 is a 200-pound electrically-operated suspended-sediment sampler that can be used to take a sample at a point in a stream cross section or to take a depth-integrated sample over a range of depth. The operating mechanism in the US P-63 is like that in the US P-61. The samplers differ mainly in size, weight, and in the capacity of the sample container that can be used. The US P-63 is a cast bronze sampler, 34 inches long. Because it weighs more than the US P-61 it is better adapted to very great depths and high velocities. The sample container is usually a quart-size round milk bottle. An adapter is furnished so that round pint milk bottles can be used. The maximum sampling depth is about 120 feet with a quart sample container and 180 feet with a pint container.

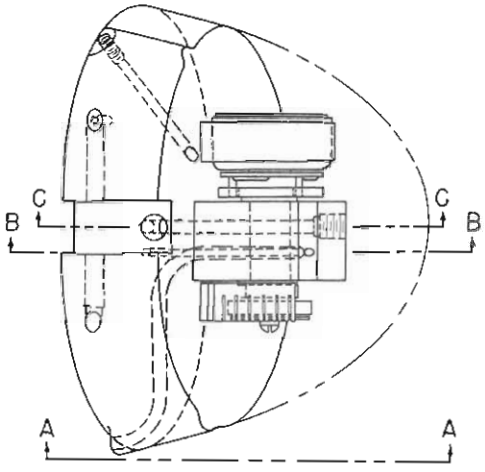
The US P-63 sampler is streamlined and it has tail vanes to orient the sampler so that the intake nozzle points directly into the approaching flow. The sampler head, which contains the electrically operated sampling mechanism, is hinged to the body at the bottom. The sample container is sealed in place when the head is closed onto the body. There is a pressure chamber in the sampler body. The air in the chamber is at the static pressure corresponding to the depth of submergence.

In the US P-63, sampling is controlled by a two-position valve. The valve is held in the first position by a spring. When a rotary solenoid is actuated electrically the valve moves into the sampling position. In the first position the intake passage from the intake nozzle to the sample container is closed and direct connection is made from the pressure chamber in the sample body to the sample container so that the air in the sample container is at the same pressure as the water at the outer end of the intake nozzle. In the sampling position the intake passage is open into the sample container, the connection to the pressure chamber is closed, and the air exhaust passage is open from the sample container to the exhaust port on the side of the sampler head.

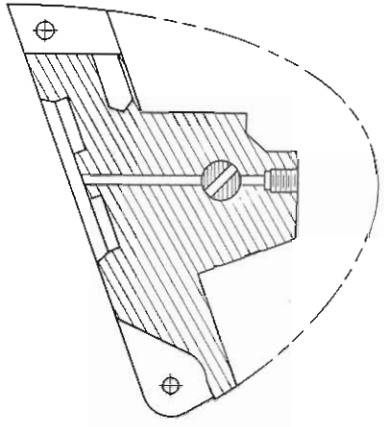
The US P-63 sampler is designed for suspension on a steel cable that has an inner conductor core that is insulated to transmit electrical energy from the operating rig to the solenoid in the sampler head. The operating current may be supplied by lantern, hot-shot, or storage batteries connected in series to produce about 48 volts of direct current. (If the suspension cable is longer than 100 feet, a higher voltage may be desirable.) The electrical circuit to the solenoid is completed through the inner core of the suspension cable to the solenoid. The solenoid is grounded in the sampler, and the ground circuit is completed through the outside of the suspension cable to the opposite terminal of the battery. The sampler takes a sample while the circuit is closed. Sampling ceases when the circuit is opened.



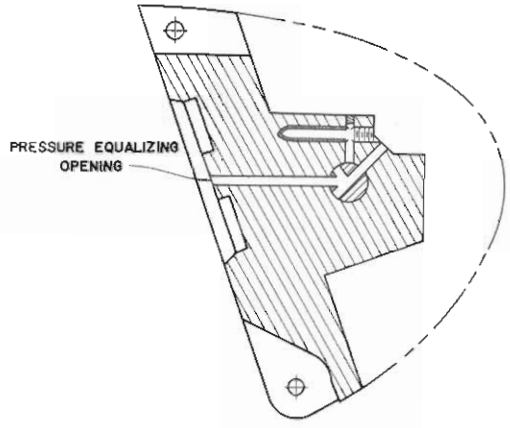
POINT-INTEGRATING SAMPLER, US P-63



PLAN

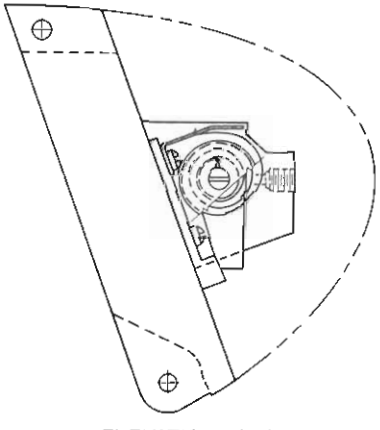


SECTION C-C

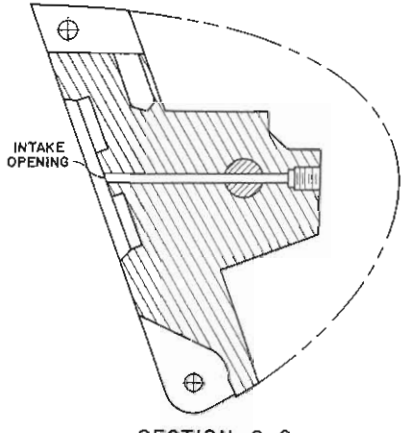


SECTION B-B

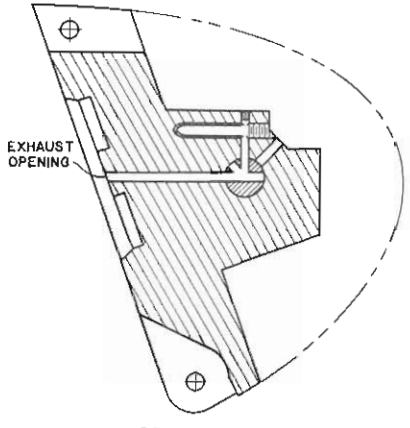
PRESSURE EQUALIZING POSITION



ELEVATION A-A



SECTION C-C



SECTION B-B

SAMPLING POSITION

POINT-INTEGRATING SAMPLER, US P-63, VALVE MECHANISM