A STUDY OF METHODS USED IN

MEASUREMENT AND ANALYSIS OF SEDIMENT LOADS IN STREAMS

REPORT I

OPERATION AND MAINTENANCE OF US P-46 SUSPENDED-SEDIMENT SAMPLER

REVISION

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A Study of Methods Used in

MEASUREMENT AND ANALYSIS OF SEDIMENT LOADS IN STREAMS

A Cooperative Project

Sponsored by the

Subcommittee on Sedimentation
Inter-Agency Committee on Water Resources
(Formerly Federal Inter-Agency River Basin Committee)

REPORT I

OPERATION AND MAINTENANCE OF US P-46 SUSPENDED-SEDIMENT SAMPLER

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

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

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

Report No. 4
METHODS OF ANALYZING SEDIMENT SAMPLES

Report No. 5
LABORATORY INVESTIGATIONS OF SUSPENDED-SEDIMENT SAMPLERS

Report No. 6
THE DESIGN OF IMPROVED TYPES OF SUSPENDED-SEDIMENT SAMPLERS

Report No. 7
A STUDY OF NEW METHODS FOR SIZE ANALYSIS OF SUSPENDED-SEDIMENT SAMPLES

Report No. 8 **
MEASUREMENT OF THE SEDIMENT DISCHARGE OF STREAMS

Report No. 9
DENSITY OF SEDIMENTS DEPOSITED IN RESERVOIRS

Report No. 10
ACCURACY OF SEDIMENT SIZE ANALYSES MADE BY THE BOTTOM-WITHDRAWAL-TUBE METHOD

Report No. 11
THE DEVELOPMENT AND CALIBRATION OF THE VISUAL-ACCUMULATION TUBE

Report No. 12
SOME FUNDAMENTALS OF PARTICLE-SIZE ANALYSIS

Report No. 13
THE SINGLE-STAGE SAMPLER FOR SUSPENDED SEDIMENT

Report No. 14 ***
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Report A -- PRELIMINARY FIELD TESTS OF THE U.S. SEDIMENT-SAMPLING
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Report B -- FIELD CONFERENCES ON SUSPENDED-SEDIMENT SAMPLING SEPTEMBER 1944
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Report C -- COMPARATIVE FIELD TESTS ON SUSPENDED-SEDIMENT SAMPLERS
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Report D -- COMPARATIVE FIELD TESTS ON SUSPENDED-SEDIMENT SAMPLERS
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Report E -- STUDY OF METHODS USED IN MEASUREMENT AND ANALYSIS OF SEDIMENT
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(Paper presented at ASCE convention, Spokane, Washington)

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

Report G -- PRELIMINARY REPORT ON U.S. DH-48 (HAND) SUSPENDED-SEDIMENT
**   SAMPLER
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Report H -- INVESTIGATION OF INTAKE CHARACTERISTICS OF DEPTH-INTEGRATING
**   SUSPENDED-SEDIMENT SAMPLERS AT THE DAVID TAYLOR MODEL BASIN
NOVEMBER 1954

Report I -- OPERATION AND MAINTENANCE OF U.S. P-46 SUSPENDED-SEDIMENT
SAMPLER   REVISION 1958

Report J -- OPERATING INSTRUCTIONS, SUSPENDED-SEDIMENT HAND SAMPLER,
U.S. DH-48   NOVEMBER 1958

Report K -- OPERATOR'S MANUAL (PRELIMINARY), THE VISUAL-ACCUMULATION-TUBE
METHOD FOR SEDIMENTATION ANALYSIS OF SANDS   REV OCTOBER 1958

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

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

Report N -- INTERMITTENT PUMPING TYPE SAMPLER   FEBRUARY 1960

Report O -- INSTRUCTIONS FOR SAMPLING WITH U.S. D-49 SUSPENDED-SEDIMENT
SAMPLER   MARCH 1960

Report P -- DIFFERENTIAL-PRESSURE GAGES FOR MEASURING SUSPENDED-SEDIMENT
CONCENTRATIONS   JUNE 1960

Report Q -- PUMPING SAMPLER WITH ALTERNATE SUSPENDED-SEDIMENT HANDLING
***   SYSTEMS

** Out of print   *** In preparation

TABLE OF CONTENTS

Instructions for the Operation and Maintenance of
US P-46 Suspended-Sediment Samplers

ILLUSTRATIONS

Figures

INSTRUCTIONS FOR THE OPERATION AND MAINTENANCE OF US P-46 SUSPENDED-SEDIMENT SAMPLERS

I. INTRODUCTION

1. Scope of these instructions--These instructions are applicable to US P-46 suspended-sediment samplers except those bearing serial Nos. 40 to 50, inclusive, which have a sliding valve mechanism. The samplers discussed here were constructed from plans dated October 1947 or revised plans dated December 1953 and May 1956. The first instruments were delivered to the field offices in the spring of 1948.

This discussion was prepared primarily to aid the field men who use the US P-46 sampler to better understand its operation and maintenance. The instructions cover samplers having valve mechanism actuated by a clock-type spring or by a rotary solenoid. Some of the troubles experienced with the operation of the sampler, their cause and remedy are discussed. Some general procedures and techniques for taking samples are presented. This manual is a revision of one dated December 1953.

II. DESCRIPTION OF THE US P-46 SAMPLER

2. General description--The US P-46 sampler was designed to collect a suspended-sediment sample at any point beneath the surface of a stream. A sample taken at one point is integrated over the duration of the time of sampling, and in this discussion is called a point sample. The sampler may also be used to take a sample continuously over a range in depth. This type of sample is called a depth-integrated sample. The rate at which a sample is collected depends almost directly on the velocity in the stream at the sampling point.

The sampler weighs 100 pounds. It is made of cast bronze; it is streamlined and equipped with tail fins to orient the sampler in flowing water. A nozzle for collecting the sample projects into the stream from the head of the sampler. The valve mechanism is enclosed in the head of the sampler and is electrically actuated to start and stop the sampling process. The body has a cavity into which a pint milk bottle is inserted to receive the sample. 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 second body cavity which is connected by ports to the surrounding stream and to the sample bottle through the valve system. A drawing of the sampler is shown in Fig. 1.

3. Valve mechanism--The valve is actuated by either a clock-type spring or a rotary solenoid. The closk-type spring must be wound for every four or five samples. Rotation of the valve powered by the clock-type spring is controlled electrically by an escapement which is triggered by a plunger-type solenoid. A drawing of this valve mechanism is shown in Fig. 2. Details of parts and a parts list are given in Fig. 3 and 4.

The valve in the more recent US P-46 sampler is actuated by a rotary solenoid which loads a coil type ratchet-drive-spring. Also, some of the older models have been modified to include the rotary solenoid. A description of this mechanism is given in Section 35 and 36. Fig 5 and 6 show drawings and a parts list of the rotary-solenoid mechanism. The latest revisions to the mechanism are shown in Fig. 7 and 8.

Rotation of the sampler valve, whether actuated by the clock-type spring or rotary solenoid, is arrested at three fixed positions, thus permitting three separate alignments of air and fluid passageways through the valve plug. At one position of the valve, which may be called the first position, or the pressure equalizing position, the air passage from the pressure equalizing chamber in the body casting is connected through the valve plug to the sample container, and the other passageways are completely shut off. The pressure equalizing, or first, position would normally be that selected preparatory to submerging the instrument to the sampling point. With the valve in the first position, energizing the solenoid once trips the operating mechanism and permits the valve to rotate 120° to the second position, or sample collecting position. This simultaneously opens the fluid intake passageway to the bottle and the air escape passageway from the bottle, and closes the passageway to the pressure equalizing chamber. Energizing the solenoid a second time rotates the valve 120° into the third, or closed, position in which all passages are closed and sampling ceases. After the sampler has been raised and the sample removed, the solenoid may be energized a third time to return the valve thru 120° to the first position.

4. Modified winding device--Some models have been equipped with the winding plug assembly (P46-55), detailed in Fig. 3 for winding the valve driving clock-type spring. This winding device is part of

the head cover and consists of a machined brass shaft containing an eccentrically mounted stainless-steel machined rod with pins projecting from its inner end. The outer end of the device is recessed to accommodate a hexagonal socket wrench. Leakage is prevented by "O" ring sealing gaskets. Clockwise rotation of the plug by means of a socket wrench engages the end pin projecting from the winding plug with the 1/8-inch pin projecting from the valve nut. Continued clockwise rotation with additional force winds the valve driving spring. Counterclockwise rotation of the winding plug to coincidence with the surface profile of the head disengages the winding assembly from the valve and permits free operation of the valve mechanism. Precise orientation of engaging pins on the winding device and the valve nut is critical. Improper position or projection of these pins will result in malfunctions. Worn or damaged pins may be replaced in the field using proper lengths cut and dressed from hardened 1/8-inch diameter stainless-steel rod.

III. AUXILIARY EQUIPMENT USED WITH THE US P-46 SAMPLER

5. General--The auxiliary equipment discussed in this chapter is used with US P-46 samplers having either the clock-type spring or the rotary-solenoid mechanism. The discussion of the switch and circuit in Section 12 and 13 applies only to the sampler having the clock-type spring. The switch and circuit for the sampler having the rotary solenoid are discussed in Section 38 and 39.

6. Mounting--The sampler requires about the same mechanical support that is necessary to successfully handle a 100 lb. stream-gaging weight. The sampler is usually suspended on a cable wound on a sounding reel. Reel mountings similar to those used for stream gaging are generally employed. The samplers may be operated from a cable car suspended on a cable across the stream at the section to be sampled. The samplers are frequently used from a bridge with some type of portable crane. Satisfactory light-weight callapsible cranes mounted on four-wheel bases are available. This type of crane and base requires counter weighting for stability. There are also cranes which are mounted on cars or trucks for operation directly from the roadway of a bridge.

7. Reel--The reel must have a drum of sufficient capacity to handle the maximum length of cable required. The drum should be no less than 12 in. in circumference and a larger size is desirable. The reel should be equipped with a depth indicator and it should have a commutator to simplify the electrical connection to the insulated core of the suspension cable. The "A" or "B" type reels of the U. S. Geological Survey are satisfactory for most of the work to be done with the US P-46 sampler.

8. Cable--A 1/8-in. steel cable with an insulated core is recommended. The cable must be of sufficient length to accommodate varying field conditions and to reach the bottom of any stream encountered. The 1/8-in. Ellsworth reverse lay cable used by the U. S. Geological Survey is generally satisfactory. The steel cable should be securely fastened to the reel. The insulated core of the cable should be stripped of the outer steel shield and connected to the commutator ring on the reel so that an electrical circuit may be made through the commutator.

9. Connector and hanger bar--The "spiral connector", "C" type hanger bar and hanger-bar pin for the "50 C" sounding weight make a satisfactory combination for connecting the cable to the sampler. This constitutes a mechanically strong support and provides for an

insulated electrical connection from the core of the suspension cable to the binding post on the sampler head cover. The hanger bar and pin fit the slot and pin hole in the top of the body of the sampler, (see Fig. 1). The electrical connection from the core of the suspension cable to the terminal on the sampler head can be made with a short piece of insulated wire. If the spiral connector is insulated with a fiber bushing, the insulation should be removed or shorted around to provide a ground connection from the outside conductor of the suspension cable through the hanger to the body of the sampler.

10. Voltage required--About 100 to 125 ft. of 1/8-in. suspension cable is generally used on the drum of the sounding reel. The resistance of the insulated core of this cable should not exceed 8 ohms, and the resistance of the outside conductor of the cable should not exceed 2 ohms. The resistance of the solenoid in the sampler valve mechanism should be about 12 ohms. A direct current of approximately 48 volts is recommended for the operation of the sampler under these conditions. A longer suspension cable will require greater voltage.

11. Batteries--The following types and combination of batteries have been used and are recommended to supply 48 volts for the operation of the US P-46 sampler under normal conditions:

(1) Eight 6-volt lantern-type dry batteries connected in series. These batteries are light in weight and will last a reasonably long time if carefully used.

(2) Eight 6-volt dry batteries of the "Hot Shot" type connected in series. These units are heavier than the lantern batteries but will last longer.

(3) Storage batteries, in sufficient numbers to supply 48 volts in series. These batteries are relatively heavy and do not lend themselves readily to transportation, but they may be recharged when necessary.

If the best service is desired, batteries for operating the sampler should never be allowed to discharge continuously for more than a second or two at a time. Furthermore, a continuous current through a solenoid may burn out the coil. Under normal sampling conditions, the lantern batteries should last for more than a week of steady sampling. However, they can be ruined in a few moments on a short curcuit.

Since 48 volts may give a serious shock under certain conditions, the operator should guard against contact with live points in the electrical circuit.

12. Switch for clock-type-spring mechanism--The electrical switch should be simple and must make a positive, sure contact when closed. The current must flow without interruption until the switch is opened again. A switch which makes a "wiping" contact is preferable to one that makes a "touch" contact. A momentary push type switch, in which the current flows only while the switch button is depressed, provides less opportunity for the current to be left on over excessively long periods of time. Provision should be made for mounting the switch in a place convenient for operation.

13. Circuit for clock-type-spring mechanism--An insulated wire should be used to connect one terminal of the batteries to one terminal of the switch. A second insulated wire should be used to connect the other terminal of the switch to the frame of the sounding reel. The other terminal of the batteries should be connected with an insulated wire to the commutator on the reel.

When the switch is closed, the current should flow as follows: From the battery to the commutator, through the commutator to the insulated core of the suspension wable, through this core; from the core through an insulated wire connection to the binding post on the sampler head cover, through the insulated binding post; from the inner end of the binding post in the sampler head cover through an insulated wire to the binding post on the solenoid, and through the solenoid coil to ground on the inside of the solenoid case. Note that to this point the electricity follows an insulated path. The current returns to the batteries through a ground circuit as follows: From the solenoid case through the headless set screw and solenoid bracket to the sampler head base and body, through the hanger bar and spiral connector to the outer portion of the suspension cable, from the cable through the drum and frame of the reel and from the reel through the switch to the battery.

IV. CARE OF THE US P-46 SAMPLER

14. Care and handling--The US P-46 suspended-sediment sampler is a moderately delicate instrument which is designed for precise work. As such, it is entitled to careful handling and conscientious servicing. The cost involved in producing and repairing the sampler and the nature of its use require effective maintenance and accurate adjustments to safeguard the investment and to accomplish the objectives of the work for which it was built.

Reasonable care should be exercised at all times to prevent damage to the body, catch, hinge, intake nozzle, exhaust opening, binding post, and tail vanes of the sampler, The condition of the intake nozzle, and especially of the intake nozzle tip, is of primary importance to the proper operation of the sampler. Therefore, extreme care of the nozzle is required. (The appearance of nozzles which have been returned for repair indicates that damage frequently results from the nozzle striking bridge rails and other bridge members.)

A suitable box or cradle should be provided for shipping or transporting the sampler. The instrument must be so crated or cradled that it cannot roll or jar loose. The nozzle should be removed from the head of the sampler unless provision has been made to protect it when in place. Protection should be provided for the air exhaust port on the side of the sampler head base.

When the sampler is not in use, the batteries should be disconnected, and the valve spring should be unwound in those samplers having a spring.

15. Care in dismantling and assembling--Work on the sampler should be carefully done. Care is required to avoid damage to threads, to screw heads, and to finished surfaces. The proper tools for the job should always be used. Gaskets must be replaced as required.

16. Replacement of parts--If parts are to be replaced, the new parts should be carefully made and properly fitted. The action of the sampler should always be tested after repairs have been completed. Detail drawings of parts are shown in Fig. 1 to 8 inclusive.

17. Inspection--Whenever the sampler is taken apart, a careful inspection should be made of every exposed part of the instrument. At least once a week the head cover gasket, the bottle gasket, and the gasket in the air compression line should be inspected. The sampler

should be immersed with the valve in the closed position for a few minutes then inspected to determine if any leakage into the bottle occurred. The sampler should be observed as it is withdrawn from the water to note any excessive drainage of water from the air compression chamber. The presence of excessive water is generally an indication of leakage in the air compression line. The alignment of the intake passage through the valve plug with that through the valve body should be checked frequently.

Periodically, or at least after each 6-weeks period of operation, the suspension cable should be inspected at each extremity for signs of corrosion resulting from electrolysis. Serious weakening of the cable can occur at the lead-in to the reel or drum clamp and the hanger bar connector. The damaged portion of the cable should be removed and new connections made.

18. Cleaning--At the completion of a day of sampling, the sampler head should be drained. If rust has been a problem, the removal of the head cover and the drying of the mechanism is recommended.

The sampler should be cleaned and oiled lightly as often as necessary to prevent damaging corrosion. The frequency of cleaning depends on the individual sampler, and on the care it has been given. In the sampler having the clock-type-spring mechanism, the parts most susceptible to rust are the solenoid case and the solenoid plunger. Some rust on the solenoid case does no harm; however, frequent oiling and occasional painting are recommended to keep such corrosion to a minimum. Rust on the solenoid plunger is serious, and if it occurs in appreciable quantities this deposit will prevent operation of the sampler. Under any circumstances of operation, the sampler requires cleaning and oiling at least once a week.

The bore of the nozzle and the intake passage through the valve body should be inspected and cleaned frequently. Special attention should be given to cleaning the solenoid bore and plunger.

19. Oiling the clock-type-spring mechanism--All operating parts, together with any other parts which tend to rust, should be carefully dried and lightly oiled each time the head cover is removed or at least once a week. The disassembly of the ratchet, valve plug, etc. should not be necessary for a routine cleaning and oiling.

Whenever a sampler is not to be used for a few days, the head cover should be removed, and the sampler head and parts should be dried carefully. A light coating of oil should be applied, and the head should be stored where dust will not accumulate on it.

V. TO DISMANTLE AND ASSEMBLE THE US P-46 SAMPLER

20. To remove the sampler head cover--To remove the sampler head cover, first remove the forward hinge pin (P46-15A). Refer to Fig. 1 to 8 inclusive for part numbers. Take off the catch (P46-8), by removing the catch pin (P46-9), and lifting out the catch and catch spring (P46-10). For samplers having the clock-type-spring mechanism, take out the socket screw (P46-41) and wind the valve spring. Remove the intake nozzle nut (P46-12), then the intake nozzle (P46-11). Next lossen slightly the $\frac{1}{4}$ in. machine screws (P46-34) which hold the head cover (P46-2) on the head base (P46-3), then remove them all. Gently remove the head cover from the head base. This may require a little patience, as the clearance between the head cover and some of the parts mounted on the head base is very small. The solenoid plunger may fall out when the cover is removed. There is a connecting wire between the inner end of the binding post (P46-33) in the head cover and the solenoid. The head cover should be carefully handled until this wire has been disconnected.

21. To replace the sampler head cover--The action of the sampler valve and escapement should be tested immediately prior to replacing the head cover on the head base after cleaning and repairs have been accomplished. A current of about 24 volts is best for testing at this time. To test the clock-type-spring mechanism, one wire from the batteries should be grounded on the head base, the valve spring wound, the head base held in approximately the position in which it would be found in sampling and the plunger properly oriented in the solenoid bore. Then touch the other wire from the batteries to the binding post in the valve body or to the end of the wire on the solenoid. Each time the battery wire makes contact, the valve plug should turn one-third of a revolution.

After the action of the valve mechanism has been checked and found to be satisfactory, the head cover may be replaced using the following procedure. Wind the valve spring if the sampler is of the type which has this spring. Attach the wire which connects the solenoid to the binding post in the head cover. Dispose this wire in the head cover so that it will not interfere with any of the moving parts. Work the head cover gently into place on the head base. When the head cover is in place, it should be held loosely with the nine $\frac{1}{4}$ in. machine screws. All of the screws should be started and turned loosely into place but not tightened. The intake nozzle may be assembled next. The nozzle gasket should be placed around the nozzle near the middle. Then the nozzle may be inserted through the hole in the head cover and screwed into the valve body. The nozzle must be turned down snugly, but never forced into place. The nozzle nut may be placed over the nozzle and tightened down on the nozzle gasket. The nine screws holding the head cover on the head base should now be turned down firmly, but not forced too tightly.

Finally the catch should be reassembled, and the sampler head reattached to the hinge. The sampler spring should be unwound if the sampler is not to be used immediately. The socket screw should be replaced, noting especially that the socket screw gasket (P46-13) is in place and in good condition. The face of the socket screw should end up flush with the outside of the head cover and with the gasket well compressed.

The action of the sampler valve and escapement should be tested again after assembly, using the procedure given above. For the sampler having the clock-type spring the circuit should now be completed by touching the wire from the battery to the binding post in the head cover. Failure of operation at this point may be due to trouble at the binding post in the head cover, to poor wiring between the binding post and the solenoid, loss of the solenoid plunger, or to the binding of some part of the operating mechanism against the head cover.

22. <u>To replace a plunger-type solenoid</u>--To remove the plunger-type solenoid, first disconnect the wire to the solenoid binding post. Then remove the two screws (P46-35) which hold the solenoid bracket and remove the solenoid bracket (P46-31) and the solenoid. The solenoid may be freed from the bracket by loosening the headless set screw (P46-51). The solenoid plunger (P46-32) lies loosely in the solenoid and may fall out any time after removal of the head cover.

To assemble the solenoid unit, place the solenoid bracket over the solenoid in such a way that when the bracket is attached to the head base, the binding post on the solenoid will point upward toward the valve body. Next secure the bracket lightly to the head base with the two machine screws (P46-35). Then, if the solenoid plunger and core are clean, the plunger may be slipped into place. With the escapement all the way down in front of the ratchet tooth, center the solenoid plunger in the solenoid. Move the solenoid until the plunger points toward the bottom of the lower arm of the escapement. The upper end of the solenoid plunger should be about 1/32 in. away from the lower part of the escapement. Then tighten the bracket screws sufficiently to hold the solenoid lightly in place and tighten the headless set screw (P46-51) slightly.

Recheck the position of the solenoid. With the escapement held fully down in front of a ratchet tooth, energize the solenoid by connecting about 24 volts of direct current to the binding post wire on the solenoid and to the head base or solenoid bracket. The solenoid case must be grounded to the head base in order to complete the electric circuit. The headless set screw will generally make a satisfactory ground connection providing it penetrates any paint or other insulating coating on the solenoid case. The current will cause the solenoid plunger to center itself in the solenoid. In this position there should be a space of about 1/32 in. between the upper end of the plunger and the lower side of the escapement, otherwise, during operation, the escapement may skip past some of the valve positions.

In some samplers there is an independent electrical binding post installed in the valve body. In these samplers the wire from the binding post of the solenoid should now be connected to the lower end of the independent binding post.

The solenoid binding post must clear the escapement, the valve spring, and the valve body. If an uninsulated portion of the binding post or of the connecting wire can touch other parts of the sampler, an electrical short circuit will result. When all requirements of position and clearance are fulfilled, the bracket screws and the headless set screw may be tightened down snugly. The clearance should then be rechecked and corrected if necessary.

23. To remove and replace the clock-type valve spring--The clock-type valve spring (P46-20) may be disassembled by removing the valve-spring-guide screw (P46-22) and the valve-spring guide (P46-21). Next the valve spring may be worked off af the valve ratchet and out of the spring stud (P46-36). Then the second valve-spring guide (P46-49) may be removed.

The valve spring unit is reassembled as follows: The valve-spring guide (P46-49) should be placed over the cylindrical portion of the valve ratchet (see Section A-A in Fig. 2). Then while facing the ratchet end of the valve plug, place the valve spring in the position shown in Fig. 3. The short bent section at the inner end of the spring must be fitted into the spring slot as shown in the view of the valve ratchet in Fig. 3. In order to slide the inner coil of the spring over the cylindrical section of the valve ratchet, the coil may have to be spread somewhat. This is accomplished by inserting thin-nosed pliers inside the coil and opening the jaws, thus forcing the coil outward. With the coil spread in this manner, it may be held at the end of the valve ratchet and worked into place. The valve-spring stud should be screwed into the valve body as far as possible but with the slot in the stud turned in position to receive the spring. The outer end of the spring may be slipped into the slot in the stud with the bent section at the end of the spring lying beyond, but against, the far side of the stud. Winding up the spring slightly by hand will usually aid in placing the outer end of the spring. The outer face of the spring coil should then be covered with the other valve-spring guide and the guide should be secured snugly in place with the valve-spring-guide screw.

24. To remove and install the escapement--After the valve spring and guides have been removed as discussed in Section 23, the escapement (P46-26) may be disassembled by first removing the escapement-pin nut (P46-25) and the escapement pin (P46-27). Then the escapement will be freed from the valve body (P46-48). To assemble, hold the escapement in the position shown in Section B-B of Fig. 2 and insert the escapement pin. The escapement pin should be tightened firmly in place by means of the escapement-pin nut (P46-25).

A new escapement will have to be individually fitted to the sampler. The upper arm of the escapement must be filed or ground down to the precise length required to give perfect alignment of the intake passage through the valve plug, when the valve is in the sampling position. In addition, the face of the upper arm of the escapement must be finished off smoothly and shaped as shown in Fig. 3.

25. To remove and install the ratchet--The valve ratchet (P46-46) may be slipped off of the valve plug after the valve spring is removed as discussed in Section 23.

The valve ratchet may be assembled as follows: The open position of the valve plug, the position for taking a sample, can be found by blowing into the exhaust port, and rotating the valve plug until the position is found for which air comes out of the air passage to the bottle. Maintain this sampling position carefully while the valve ratchet is placed on the valve plug. The tooth side of the ratchet goes on first, next to the valve body. There are four positions in which the valve ratchet can be installed on the square shank of the valve plug. There is only one correct position, however. The correct position is such that one of the ratchet teeth comes flush with the end of the upper arm of the escapement when the valve passage is in alignment for taking a sample. There is no other satisfactory assembly position for the ratchet. If placed in an incorrect position, some freakish samples may result. In general, incorrect assembly of the ratchet will result in an insufficient sample. Index marks on the ratchet and valve plug of most of these instruments indicate the proper ratchet position, however these marks should be checked for correctness.

If a new ratchet is being installed, the length of the escapement arm must be made to fit the ratchet, so that the alignment of the intake passage will be perfect when the valve plug is in the sampling position. The entire operating mechanism in the head of the sampler should be available to the machinist who is to make replacement parts or install them.

26. To remove and replace the valve plug--To remove the valve plug (P46-19) from the valve body, first unwind the valve spring then remove the valve nut (P46-24). Then the valve plug (with the valve ratchet and valve spring attached) may be worked out of the valve body. Some of the valve nuts are equipped with a small set screw for locking the nut in place. Such a set screw should be loosened before attempting to remove the valve nut.

Before assembly, the valve plug and the barrel in the valve body should be carefully wiped with a clean cloth. Both should be covered with a good grade clock oil or other light oil, assembled loosely, and the valve plug should be rotated a few turns. This procedure should be repeated until wiping no longer smudges the cloth. Extreme care should be used to keep sand out of the valve barrel. All valve parts must be carefully cleaned before assembly.

Before beginning assembly, the thrust collar (P46-42) should be solidly in place on the valve (see Section A-A on Fig. 2). If the collar is ever found loose on the valve plug, it should be tightened in place in the position shown in Section A-A. The material in the valve plug may be expanded against the collar by careful use of a punch. With the thrust collar firmly in place on the valve plug, the valve washer (P46-23) is dropped over the end of the valve plug so that it rests against the thrust collar as shown in Section A-A. The valve may then be inserted in the valve body receiver.

The clean valve nut (P46-24) is screwed onto the valve plug until the valve washer is drawn nearly tight against the valve body. There should be just enough end play in the valve plug so that movement can be felt when the plug is pushed from side to side in the barrel. The valve should now be turned so that the intake passage in the valve plug lines up with the passage in the valve body. The alignment of the passages, which should be perfect, can be observed by moving the valve plug from side to side in the valve body. If the valve nut has not drawn the valve plug quite far enough to provide the best alignment, the nut may be tightened a very small amount then backed off again to improve the alignment of the valve passage and still allow the required clearance. If the nut appears to have drawn the valve plug too far, it may be necessary to correct the placement of the thrust collar on the valve plug. As a last resort, the alignment of the valve passage may be improved by replacing the valve washer with one of the proper thickness. Failure to rotate freely may mean that there is dirt in the assembly, that the valve nut is too tight, or that parts have been damaged. Once proper adjustment of the valve nut has been made, the nut must hold that position. All valve nuts are lock nuts and some have been equipped with a No. 8 stainless-steel set screw to hold the nut in place. An Allen wrench should be available for tightening this set screw when the valve nut has been placed in final assembled position. If there is no cotter-pin or set screw on the valve nut one should be installed if the nut does not remain in place.

VI. ADJUSTMENT AND REPAIR OF THE US P-46 SAMPLER AND AUXILIARY EQUIPMENT

27. General--Difficulties which may be experienced in the operation of this US P-46 sampler, their detection, cause and remedy are discussed in this section. The major difficulties are: (1) improper size of sample, (2) electrical circuit troubles, (3) valve mechanism troubles and (4) water in sampler head.

This discussion applies specifically to the sampler having the clock-type spring-driven valve. However, many parts of the discussion are also applicable to the sampler having the rotary solenoid. A thorough knowledge of the instrument will be most helpful in analyzing and remedying the difficulties which may arise in its operation.

28. Testing for type and source of difficulty--Whenever the operation of the sampler becomes questionable the following simple tests should quickly determine the general nature, source and location of the trouble.

a. Check size of sample. The first indication that the sampler is not operating properly may be its failure to obtain a sample or one of proper size. A sample of proper size fills a pint milk bottle 4 to 5 inches from the bottom or to about the center of the tapered portion. Inspection will show whether a sample is of proper size. The operator should be alert at all times to detect any samples of improper size. Discussion of the causes of improper size of samples will be found in Section 29.

b. Tests for electrical circuit troubles. The electrical circuit includes the batteries, switch, commutator on the reel, suspension cable with insulated inner core conductor, cable connector and hanger bar, binding post on sampler head, solenoid in sampler head and short lengths of insulated wire which connect various elements of the system. The electrical circuit will be the source of many troubles unless it is well constructed and carefully maintained.

To determine whether the electrical trouble is inside the sampler head or outside the sampler head, the following tests should be made:

(1) Check movement of solenoid plunger. It should be possible to hear or feel the impact of the solenoid plunger from the outside of the sampler head. When the sampler is assembled, the spring wound, and the instrument in position for operation, tests for motion

of the plunger may be made by rapidly closing and opening the switch several times and at the same time listening or feeling for the impact of the plunger. If at any time the impact of the plunger cannot be either heard or felt at the outside of the head cover, the sampler action should be tested further by using a source of about 24 volts of direct current connected directly to the sampler head with short wires rather than through the circuit of the suspension cable and commutator on the reel.

(2) Trouble in circuit outside sampler head. Operation of the solenoid plunger with the batteries connected directly to the sampler head, as discussed in the preceding paragraph, but failure to operate when connected through the operating circuit, indicates trouble in the circuit outside the sampler head. For discussion of troubles in the circuit outside the sampler head see Section 30.

(3) Trouble in sampler head. If there is no audible movement of the plunger when the batteries are connected directly to the sampler head in the above test, the trouble may be with the electrical system inside the sampler head, including the solenoid, as discussed in Section 31. Or the plunger may not move freely as discussed in the following paragraph.

c. Check for free movement of solenoid plunger. If there is no audible impact when the sampler head is directly connected to the source of current, the next test should be to determine whether the solenoid plunger will move freely. This test is made by turning the head of the sampler upside down a few times and listening for the free fall of the solenoid plunger. As the head is turned over, with the valve spring at least partly wound, the sliding of the plunger should give an impact that may be both felt and heard.

If the plunger does not slide freely as shown by this test see Section 32a.

When the plunger does slide freely as the sampler head is turned over, the trouble may be with the electrical system inside the sampler head and further inspection and tests should be made as discussed in Section 31.

d. Check rotation of valve plug. There may be times when the plunger strikes the escapement, but the operation of the sampler valve is still inadequate. To inspect the rotation of the valve plug, remove the socket screw from the winding hole in the sampler head cover and insert the socket screw wrench in the recess in the valve plug. Check the operation of the valve by watching the wrench as the electrical circuit is made and broken. At each closure of the circuit, the valve plug should turn 1/3 revolution. Check the operation of the valve with varying degrees of tension in the valve spring. If the valve does not always rotate when the circuit is closed, but the plunger can be heard to operate, see Section 32.

The sampler valve may rotate each time the circuit is closed but may turn more than 1/3 of a revolution to skip past some positions. For a discussion of this difficulty see Section 33.

29. Improper size of sample--Almost any defect in the sampler or its operation will give a sample of improper size. Therefore, the operator of the sampler should be on the alert to detect samples which are out of proportion to the stream velocity and sampling time; remembering that if the sampler drifts downstream during sampling, the actual velocity at the intake nozzle is reduced by the rate of downstream drift. See Section 52 for effect of downstream drift of the sampler. The defects in size of sample and some of the probable causes are as follows:

a. No sample. If no sample is obtained, the cause may be as follows:

(1) Sampler valve incorrectly set. An incorrect position of the valve prior to sampling is a common cause of trouble. The valve has three positions in the following order: (a) pressure equalizing, (b) sampling, and (c) closed. The position of the valve must be known and must be correct before the sampler is lowered to the sampling point. For example, if the valve is in the closed position when the sampler is lowered to the bottom of the stream in preparation for depth integrating from the bottom to the surface, then pressing the switch button once will set the valve in the equalizing position and no sample will be taken as the sampler is raised to the surface.

(2) Sampler valve fails to turn. If the valve fails to turn to the open position, no sample will be taken. Failure of the valve to turn may be due to trouble with some part of the valve operating mechanism which includes (a) the electrical circuit, (b) solenoid plunger, (c) solenoid coil, (d) ratchet and escapement, (e) valve driving spring, and (f) valve plug. These troubles are discussed in Section 30, 31, and 32.

(3) Sampler valve skips. The sampler valve may skip past the open position and so fail to collect any sample. This skipping may be caused by a mechanical defect, maladjustment of the mechanism; or by improper operation of the electrical circuit as discussed in Section 33.

(4) Intake nozzle plugged. If the nozzle or intake line is completely plugged with mud or sand, no sample will be obtained.

(5) No stream velocity. These samplers will usually operate in a pool in which there is little or no stream velocity, but there may be occasional instances when no sample will be collected. The differential pressure caused by the difference in elevation between the intake nozzle and air exhaust port may not be sufficient to cause filling in still water.

b. Insufficient volume of sample may be caused by the following:

(1) Sampler valve incorrectly set before sampling was started. If the sampler valve is set in the wrong starting position, for example, if it is set in the open position, the sample will be taken during the interval of time that the sampler is being lowered to the sampling point, and the result probably will be a sample of insufficient size.

(2) Sampler valve fails to turn. The sampler valve may not turn the first time the switch is closed to rotate the valve from the equalizing to the sampling position but may turn the second time the switch is closed, thus placing the valve in the sampling position rather than the closed position as intended. The actual time of sampling then extends from the second closing of the switch until the sampler emerges from the water. If this actual time of sampling was shorter than the intended time of sampling, the sample would be unexpectedly small. Failure of the valve to turn may be caused by some mechanical or electrical trouble as discussed in Sections 30, 31 and 32.

(3) Sampler valve skips. If the sampler valve skips past the open position, it may not take a sample during the intended sampling time. When the switch is closed a second time, the valve may skip to the open position and thus sample only while the sampler is being returned to the water surface, thus obtaining an insufficient sample. Skipping of the valve may be caused by some mechanical or electrical trouble as discussed in Section 33.

(4) Intake not fully open. Poor alignment of the passage through the valve plug with that through the valve body may cause partial obstruction of the intake passage and result in an insufficient sample. Mud or debris in the intake passage will have the same effect. Damage to the intake nozzle may constrict the intake passage.

(5) Debris on end of nozzle. Under certain conditions of debris movement in streams, insufficient samples may be obtained because fine drift lodged on the end of the intake nozzle. Sometimes this material may be found on the end of the nozzle when the sampler is raised for emptying. Many times the debris will have vanished by the time it is possible to inspect the sampler. In any case, the undersized samples are not reliable.

(6) Air exhaust line plugged. The air exhaust line may be obstructed with mud or it may be partially closed by having been bent or otherwise damaged thus resulting in an insufficient sample. A plugged line may generally be cleaned with compressed air, but mechanical means of cleaning may be necessary.

(7) No velocity of flow. These samplers will usually operate in a pool in which there is no velocity of flow but the sample is collected very slowly, resulting in an insufficient sample.

c. Excessive volume of sample or overfilling of the bottle may be caused by the following.

(1) Sampler valve incorrectly set before sampling was started. If the sampler valve was set in an incorrect position prior to sampling the sample may be excessive because the sampling time was longer than intended.

(2) Sampler valve fails to turn. A common cause of too large a sample is failure of the sampler valve to close at the end of the proper sampling time. This may be caused by some mechanical or electrical trouble as discussed in Sections 30, 31 and 32.

(3) Sampler valve skips. As discussed in Section 33, the sampler valve may skip positions so that it is in the open position at times other than the intended sampling time, thus taking an excessively large sample.

(4) Pressure equalizing system not operating properly. One position of the valve allows the pressure in the sample bottle to

equalize with the hydrostatic pressure outside the intake nozzle. If the pressure is not equalized, there is an initial inrush of water when the valve is opened to the sampling position. This initial inrush may cause overfilling of the sample bottle. The several conditions which may cause the system to fail to operate are as follows: (a) the valve may skip, (b) the two intake holes under the sampler body for the equalizing chamber may be obstructed (c) the equalizing chamber may be full of mud or sand, (d) the air lines may leak, or, (e) the gasket on the air line system between the body of the sampler and the head base may be faulty.

(5) Bottle gasket not sealing properly. A defective bottle gasket, or a weak bottle spring, may result in a poor seal around the top of the sample bottle. This may permit water to leak in around the top of the bottle resulting in too large a sample.

30. Electrical circuit troubles outside sampler head--If the solenoid plunger fails to operate when a current of 48 volts is connected through the operating circuit and suspension cable but operates when a current of 24 volts is connected directly to the sampler head, the trouble may be in the battery or the operating circuit. Tests to locate this trouble are discussed in the following paragraphs.

a. Check for open or short circuit. There are two types of circuit failure: (a) open or broken circuit and (b) shorted or grounded circuit.

(1) Broken circuit. When there is a break in the circuit and the connection is made and broken at a battery terminal, no spark will result. A weak spark will indicate a weak battery (see Section 30b) or an inefficient circuit (see Section 30f). A normal circuit through the solenoid will give a good spark at the terminal and a short circuit will give a hot spark. When an open circuit is indicated, inspection should be made looking especially for disconnected or loose wires at terminals, or broken wires including the conductor in the core of the suspension cable (see Section 30e).

(2) Short circuit. To check for a short circuit, the circuit may be opened by disconnecting the wire to the binding post on the sampler head. Then with this known break in the circuit, making and breaking the contact at the battery will give a hot spark if there is a short or ground in the circuit. If a short is indicated a search should be made for defective or insufficient insulation.

Excessive heating of a portion of the circuit may indicate the location of a short circuit.

b. Battery failure. If the solenoid plunger does not strike hard enough to trip the escapement, the batteries may be weak. As batteries become weaker, operation, which may be satisfactory for a short time at the beginning of a sampling period, becomes erratic and undependable. The batteries should be checked and replaced if in poor or even doubtful condition. An ammeter provides the best tests for batteries, however, a voltmeter may be used. In setting up a sampler circuit, if it is found that about 42 volts will just operate the sampler, then about 48 volts should be provided to allow a margin for deterioration of the batteries or circuit. Too great a voltage should not be used because it may damage the solenoid.

c. Loose connections. All electrical connections should be checked to insure that contact wires are clean and terminals are tight. Electrical connections include terminals on the battery, switch commutator, and sampler head, and wire connections at the connector and hanger bar.

d. Check of the switch. Electrical circuit trouble may be due to loose connections on the switch or faulty switch contacts. With the sampler circuit completely set up, the switch may be checked by shorting across it with a spare wire, or by disconnecting one of the wires to the switch and touching it to the other wire leading to the switch. Such shorting should cause the solenoid to operate just as though the switch had been closed, however, if it does not, there is trouble somewhere other than the switch.

e. Check of the suspension cable. There may be times when the sampler will fail to operate when a strain is placed on the suspension cable. This indicates faulty insulation of the core or a broken core wire in the suspension cable. Inspection should be made at the point where the cable enters the connector joining the cable to the hanger bar. Also, any kinks in the cable should be investigated. Sometimes wiggling the cable at the suspected point may cause intermittent operation of the circuit and thus locate the trouble.

f. Inefficient circuit. If the electrical current supply from the battery is adequate but the impact of the solenoid plunger fails to actuate the valve mechanism consistently, the circuit may be inefficient. The cause could be loose connections at binding posts, the use of very small wires, poor switch contacts, or other sources of excessive resistance in the circuit. Special attention should be given to checking the circuit through the commutator on the reel, the connections from the insulated core of the suspension cable to the commutator, and the connections to the binding post on the sampler.

Defective or insufficient insulation may cause current leakage. The leakage may increase when the suspension circuit is partly submerged. One side of the circuit is grounded through the sampler and outer section of the suspension cable. Therefore poor insulation on the inner core conductor of the suspension cable may cause loss of current when the cable is submerged in the stream. The connection to the binding post on the head of the sampler, and the top portion of the binding post are a part of the insulated side of the circuit. There will be a certain amount of current leakage across the water gap between these two and the body of the sampler.

31. Electrical trouble inside the sampler head--If the sampler valve fails to operate when a battery current of about 24 volts is connected directly to the sampler head, the trouble may be with the electrical circuit in the sampler head, the solenoid plunger or the solenoid coil.

a. Solenoid plunger. Troubles with the solenoid plunger binding or sticking are discussed in Section 32a.

b. Check of electrical circuit in sampler head. If the solenoid plunger slides freely when checked by the method in Section 28c but fails to operate when a battery is connected directly to the binding post on the head cover and grounded on the head or body of the sampler the electrical circuit in the sampler head may be faulty. When the sampler is tested with the head cover in place, the valve plug, spring or spring guides may bind against the head cover or against other parts of the assembled sampler as discussed in Section 32d. The wiring inside the head may be checked by removing the head cover as discussed in Section 20. The binding post in the head cover, the wire from the binding post in the head to the binding post on the solenoid and the grounding of the solenoid case to the solenoid bracket should all be checked.

c. Check of solenoid connected directly to battery. If the solenoid fails to operate when a current of about 24 volts is applied directly to the binding post and to a good ground on the solenoid case, the solenoid has probably failed. The resistance of the solenoid should be about 12 ohms. A short circuit of some of the coils in the solenoid will reduce the resistance and lower the efficiency of the solenoid. The loss of efficiency will be in approximate proportion to the reduction in resistance. An open circuit in the solenoid will be shown by an extremely high resistance. A defective solenoid will generally have to be rewound, or replaced with a new one.

32. Valve mechanism troubles--The sampler valve may fail to operate because the solenoid, the valve plug, the clock type spring or the escapement do not function properly. Troubles with these parts are discussed in the following paragraphs.

a. Solenoid plunger does not slide freely. The plunger may not slide freely because it and the solenoid core are dirty, corroded or wet. If the plunger still does not slide freely after being cleaned, the plunger may be binding against the head cover.

If the plunger is binding against the head cover, it may be loosened as follows: Remove the pin through the catch, and take off the catch and catch spring. Remove the intake nozzle nut and intake nozzle. Loosen, but do not remove, the screws which hold the head cover on the head base. Slide the head cover slightly from side to side, while turning the head over and over. If the plunger was binding against the head cover, the slight movement of the head cover should free it, and the plunger should start to slide freely as the head is turned over. Careful observation will indicate the amount and the direction of shift of the head cover required to clear the plunger.

If loosening and shifting the head cover does not eliminate the binding, it may be corrected by a slight shifting of the solenoid bracket (P46-31) on the head base, or by a realignment of the solenoid (P46-29 and 47) in the solenoid bracket. Access to the solenoid is obtained by removing the head cover as outlined in Section 20. The plunger may bind in the plunger recess in the head cover, in which case the recess should be enlarged. The assembly of the solenoid is discussed in Section 22.

b. Solenoid plunger not striking hard enough. If the impact of the solenoid plunger fails to trip the escapement even though the valve rotates easily and the escapement trips readily, the solenoid plunger is not striking hard enough. The impact may trip the escapement when there is little tension in the spring but will fail to trip when the spring is tightly wound. Energy applied to the escapement by the solenoid plunger may be inadequate because the moment arm to the point of impact is insufficient. Added mechanical advantage may be gained by moving the solenoid impact to a point nearer the outer end of the escapement. The lack of impact is often the result of insufficient voltage at the solenoid. Poor batteries, a defective electrical circuit, or a solenoid coil failure, may account for this defect, see Sections 30 and 31.

When fully wound, some samplers require a considerable force to trip the valve. The spring on these samplers should not be wound to the final notch. With such samplers the position of the valve plug prior to sampling should be one full turn away from fully wound. If the sampler has been wound too tight, the spring should be unwound by pressing the switch button until the valve is rotated again to the desired starting position.

c. Inadequate spring action. If the sampler valve will not operate except when the spring is fully wound, or if the valve action is erratic with some tendency for the valve plug to bind when the spring is partly wound, the spring may be binding in the spring guides. Binding can be located by inspection of the spring guides. Cleaning the spring or guides may eliminate the trouble. If the guides have been bent, they may require straightening.

After continued operation, the valve spring may weaken so that only a very few samples can be obtained with each winding. A badly weakened spring should be replaced.

d. Valve plug, spring, or spring guides binding on head cover. Satisfactory operation of the valve with the head cover removed, but failure to operate with the head cover in place, is generally a sign that some operating part of the sampler binds against the head cover. Parts which may bind are the valve plug, spring, or spring guides. To locate the point of binding a spot of some marking material may be placed at the critical point and operation attempted with the cover in place. Any scar in the marking material indicates binding at that point. If sufficient thickness of metal is available at the point of binding, the inside of the cover may be cut or filed away to provide clearance. Sometimes the wire in the head obstructs the movement of one of the operating parts.

e. Valve plug binding in valve body. It should be possible to determine whether the valve plug is binding in the valve body by rotating the valve by hand when the spring is unwound. Binding may result from the valve nut (P46-24) being turned up too tightly, or from dirt or roughness in the valve plug or valve receiver.

f. Escapement and valve fail to operate. Sometimes the solenoid plunger strikes the escapement, but the valve does not operate consistently. With the head cover in place, operation of the valve should be attempted several times with varying degrees of tension in the valve spring, meanwhile noting the behavior of the valve under each condition. The head cover should then be removed (see Section 20) and the operation carefully rechecked with varying degrees of tension in the spring. Satisfactory operation with the head cover off, but unsatisfactory operation with the cover snugly in place, indicates that the mechanism binds on the head cover (see Section 32d). Failure to operate with the head cover off and the spring fully wound generally indicates that the escapement does not trip as easily as it should, due to roughness or binding (see Section 32g and h); that the solenoid plunger is not striking hard enough (see Section 32b); or that the valve plug turns unusually hard (see Section 32e).

Failure to operate with the head cover off and the spring lightly wound indicates that the valve plug turns too hard (see Section 32e), that the escapement does not clear the ratchet sufficiently (see Section 32i), that the spring action is inadequate (see Section 32c), or that the escapement is binding (see Section 32h).

g. Rough escapement arm or ratchet tooth. If the escapement does not trip when the spring is fully wound, the face of the upper escapement arm or of one of the ratchet teeth may be rough or damaged. If the roughness is on the ratchet tooth, failure will continually occur at one position of the valve plug. A small amount of roughness may be corrected by polishing with crocus cloth. Excessive removal of metal from the upper escapement arm or from the ratchet tooth that controls the open position of the valve will destroy the alignment of the intake passage.

h. Escapement binding. If the escapement seems to be binding, check for dirt, clearance from other parts of the sampler, and freedom of rotation about the escapement pin.

i. Escapement does not clear ratchet sufficiently. With the valve spring lightly wound there may be times when the valve plug rotates easily and the escapement seems free, yet the impact of the solenoid plunger is not followed by rotation of the valve. This may indicate that the escapement does not clear the end of each ratchet tooth sufficiently. The clearance may be checked by holding the escapement up and noting the clearance over the ends of the ratchet teeth as the valve plug is turned slowly. There must be clearance to permit the ratchet teeth to pass, but a minimum clearance may not be sufficient for good operation. When the escapement is driven upward by the impact of the plunger, the escapement travels rapidly to the upper limit of its motion and then rebounds downward. If the rebound drives the escapement downward before the valve ratchet commences to turn, the escapement will fall in front of the ratchet tooth which it was supposed to release. Additional clearance can be given by carefully dressing down the lower side of the upper arm of the escapement.

33. Sampler valve skips--Under certain conditions the sampler valve may skip past one or more valve positions. Such action yields no sample or one having improper size. The fault may be in the setting of the solenoid or in worn or damaged parts.

The valve may skip only when the valve spring is fully wound or when it is nearly unwound. Operation may be continued for a long time using only a part of the range of the valve spring, but such an expedient should be considered only temporary.

a. Solenoid incorrectly set. The valve may skip past some positions because the solenoid is set too close to the lower arm of the escapement, thus preventing the escapement from operating satisfactorily. See Section 22 for a discussion of the assembly and adjustment of the solenoid.

b. Worn or damaged parts. Skipping may be due to damage or wear on the face of the upper escapement arm or of one of the ratchet teeth. Sometimes the surfaces may be dressed down slightly to correct the trouble, but such repairs must be carefully made or the alignment of the intake passage will be destroyed. The only satisfactory repair may include the installation of new parts.

c. Electrical trouble. Skipping may be due to a defect in the switch or in its operation, or to a loose contact in the electrical circuit which allows more than one electrical impulse to reach the solenoid. This type of electrical difficulty is often of a mechanical nature. A careful inspection of the circuit will usually disclose the source of trouble.

34. Water in sampler head--When the sampler is in operation, the inside of the sampler head will generally be damp, and some of the time the head will contain an appreciable quantity of water. The mere presence of moisture in the head will seldom if ever prevent operation of the instrument, but rust from the continued presence of moisture may

impair operation. Water may prevent the solenoid plunger from operating properly. Moisture or water in the head of the sampler may result from any of the following:

a. Nozzle packing. Water may enter through the "O" ring packing around the nozzle. Careful assembly of the nozzle, packing, and nozzle nut will usually prevent leakage. The nozzle should be screwed snugly into place and the nozzle nut tightened down on the packing when the screws which hold the head cover on the head base are snugly in place but not tight. After the nozzle nut is tightened sufficiently to compress the packing, the head cover screws may be tightened. An insufficient length of threads in the nozzle nut recess may prevent the packing from being compressed. Two packing rings may be required to prevent leakage in this case. Packing may be damaged by excessive compression, or by projecting sharp edges. Such sharp edges should be removed. Packing may need to be replaced occasionally as a result of normal damage and wear.

b. Nozzle seat. If the nozzle is not threaded snugly into the nozzle seat, leakage may occur around the nozzle threads. The nozzle must be snugly in place before the screws holding the head cover are fully tightened.

c. Socket screw packing. Leakage may occur around the socket screw which plugs the winding hole in the sampler head. This screw must be tightened down on the "O" ring packing to prevent leakage. The packing will require replacement occasionally. Packing may be damaged by excessive compression or projecting sharp edges.

d. Valve plug. Water may seep into the head around the valve plug, but this probably would occur only when the valve barrel has been damaged or badly worn. Replacement of the valve or both the valve and valve body may be required to eliminate this leakage. Equalizing the pressure inside the sampler head with that outside by cutting a hole through the pressure equalizing tube which passes through the head may reduce the leakage around the valve plug.

e. Binding post. Water may enter around the binding post in the head cover or the lead-in plug in the head base. Tightening the nut which compresses the rubber section of the binding post or the lead-in wire gasket should seal the sampler at this point and prevent seepage. Replace rubber when required.

f. Gasket. Leakage may occur past the gasket between the head cover and head base if the gasket is defective or the screws which hold the head cover in place are not tightened uniformly. The gasket should be replaced when defective.

g. Condensation. The head cavity will frequently be damp from condensation of moisture. If the air temperature is higher than that of the water and the air humidity is relatively high, the cooling action of the water when the sampler is submerged will condense moisture from the air within the sampler head.

VII. ROTARY-SOLENOID MECHANISM

35. General description--A spring-loaded ratchet assembly, which is actuated by a rotary solenoid, has been developed to replace the original clock-type-spring mechanism for turning the valve in the US P-46 sampler. The valve plug of the sampler was unchanged except for modification of the connections at each end.

The improved mechanism was designed to fit into the head cavity of the sampler. It operates electrically through similar circuits and from the same direct current power source as the original sampler. It eliminates the need for winding a valve driving spring.

A dial-type switch assembly, located in a control box, is employed to energize the rotary solenoid in controlled steps, from a remote station. An indicator shows when the intake valve is in the open or sample-collecting position.

The rotary-solenoid mechanism and the valve-position indicator are available as replacement units to fit any of the US P-46 suspended-sediment samplers. A moderately well equipped machine shop is required for installation of the mechanism. These modifications can be made with the facilities maintained at the St. Anthony Falls Hydraulic Laboratory.

Inquiries, orders, and communications regarding repairs and modifications to US P-46 samplers should be directed to the District Engineer, U. S. Army Engineer District, St. Paul, Corps of Engineers, 1217 U. S. Post Office and Custom House, St. Paul 1, Minnesota. Unless the body section of a sampler has been damaged or needs repair, it will be necessary to forward only the head of the instrument for this modification, i.e., the parts contained within the head cover (P46-2) and head base (P46-3). Details of the mechanism are illustrated in Fig. 5 to 8.

36. Description of mechanism--A rotary-solenoid, which is pin connected to a spring-loaded ratchet assembly through a slot in the outer ratchet plate (P46-65), rotates the valve plug rapidly through one-third of a revolution, in stages of 20 degrees of arc (see Fig. 8). The ratchet wheel (P46-63) contains 18 teeth and is securely fastened to the valve plug. When the rotary solenoid is momentarily energized, the ratchet plate assembly is drawn back about 22 degrees against the tension in the ratchet drive spring (P46-76), and the ratchet driving pawl (P46-68) engages the next tooth on the ratchet wheel. The driving

pawl spring (P46-69) forces the pawl against the ratchet wheel. When the electrical impulse to the solenoid ceases, the ratchet drive spring draws the ratchet and valve forward 1/18 of a revolution or 20 degrees. The forward motion of the valve and valve mechanism which follows each electrical impulse is arrested by a positioning stop (P46-74) which in turn locks the pawl to the engaged tooth on the ratchet and prevents any further forward motion of the valve until the solenoid again reloads the driving spring. The positioning stop is adjustable to fit the mechanism and to correct the alignment of passageways through the valve. A fixed ratchet-locking pawl (P46-70A) prevents any backward rotation of the valve.

Since there are three fixed positions of the valve, each valve position is spaced 120 degrees apart and six separate electrical impulses must be delivered to the solenoid to rotate the valve to each successive position. A telephone dial with micro-switch assembly produces the six electrical impulses to the solenoid. When the number one (1) is dialed, some dials make two contacts and others make one. Number five (5) is dialed on the first type and number six (6) on the second (according to instructions in the control box) to advance the valve from one position to the next. In this manual the dial number (5 or 6) shown in the control box is called the reference number. Rotation of the valve occurs during the return stroke of the dial switch.

37. Valve position indicator--The valve-position indicating system consists of an ohmmeter and meter switch in the control box, and a low voltage battery, a contact switch and a series resistor mounted in the head cover of the sampler. The circuit utilizes the suspension cable, the dial switch and micro-switch. (See wiring diagram in Fig. 8.) When the dial is being operated, the indicator circuit automatically remains open to protect the ohmmeter from the high voltage used to operate the solenoid. When the sampler valve is in the open, or sampling position, the contact switch in the sampler head is closed. (See indicator contact assembly in Fig 7.) Then when the switch button in the control box is pressed the circuit is completed and the needle on the ohmmeter deflects to indicate that the valve is in the sampling position.

CAUTION: The meter switch in the control box should never be depressed while the dial is being operated or a high voltage may reach the meter and severely damage it. Operate the meter switch only when the dial is at rest.

38. Control-box electrical connections--To facilitate operation of the sampler valve from a remote station, a control box, containing the dial switch assembly and the position indicator, is furnished. Manipulation of the dial will operate the mechanism within the head cover of the sediment sampler. The terminals on the control box must be connected correctly to the sampler and to the proper poles of the battery, otherwise the meter needle may be forced against the needle stop and bent.

Terminals provided on the control box should be connected in sequence as follows:

Positive battery terminal. Connect the control-box terminal marked Battery (+) to the positive (+) terminal of the battery (or batteries connected in series) to furnish the voltage required.

Negative battery terminal. Connect the control-box terminal marked Battery (-) to the negative (-) terminal of the battery or series of batteries.

Positive sampler terminal. Connect the control-box terminal marked Sampler (+) to the insulated core of the suspension cable. The other end of the core should be connected to the terminal on the head of the sampler or to the lead-in wire through the head cover of the sampler.

Negative sampler terminal. Connect the control-box terminal marked Sampler (-) to the outer shield of the suspension cable at the reel. The other end of the cable shield will be grounded to the body of the sampler through the hanger bar connectors.

39. Operation of control box--After verifying proper connection of the terminals on the control box as instructed in Section 38, the control box may be used to operate the mechanism within the sampler in sequence as follows:

To place the sampler valve in the open position, dial the reference number shown inside the control box.

To check for sampling position of the valve, press the button in the control box and watch for a permanent deflection of the meter needle.

If meter needle is not deflected, dial the reference number again as instructed in this section and check for sampling position of valve by pressing the button. If needle is not deflected repeat a third time. When the meter reading signals that the valve is open, a sample can be, or is being collected.

If the third attempt to rotate the valve to the open position fails to produce a meter reading, the mechanism is not properly oriented and the appropriate reference number minus one (1) should be dialed and the button in the control box pressed repeatedly until a reading is obtained on the meter. Depress the meter switch each time only after the dial becomes motionless. A meter reading will indicate that the valve is in the open position. Thereafter, successive positions of the valve are obtained by dialing the reference number.

a. Secondary currents may deflect the meter needle slightly or momentarily, but these usually small meter readings generally produced by galvanic action and induced voltages, are inconsequential and should be disregarded. With a good battery in the position-signaling circuit the indicating needle of the meter should deflect to at least the center of the scale when the valve is open.

b. If the wrong number is dialed erroneously or orientation is lost through partial rotation of the valve plug by some other means, the open position can be recovered by dialing the reference number minus one repeatedly, as discussed in Section 39 above until the meter indicates the open position.

40. Maintenance--The cost involved in producing and repairing the US P-46 sediment sampler and the nature of its use prescribe effective maintenance and accurate adjustments to safeguard the investment and to accomplish the objectives. Refer to Chapter IV, Care of the US P-46 Sampler, and Chapter VI, Adjustment and Repair of the US P-46 Sampler and Auxiliary Equipment, to supplement the following discussion.

a. Cleaning the valve-actuating mechanism. Moisture which may collect within the head cavity from leakage and condensation should be removed daily either by separating the head cover from the base plate or by removing the intake nozzle nut and nozzle and tilting the sampler nose downward to permit drainage. At least once each week the head cover should be removed and the operating mechanism cleaned and dried. Electrical connections should be inspected and corrosion neutralized.

b. Oiling the valve-actuating mechanism. After cleaning the mechanism, a few drops of light oil may be placed between the ratchet wheel and ratchet plates (P46-63, 64 and 65). A drop of oil should also be placed on each side of the ratchet driving pawl at its pivot (P46-68). A small amount of grease should be placed on the solenoid drive pin where it engages the slot in the outer ratchet plate (P46-65 and 78).

41. Adjustments to rotary-solenoid mechanism--There are only two adjustments to be made on the rotary-solenoid mechanism. They are adjustment of the alignment of the intake bore, and adjustment of the switch contacts in the position-indicating circuit.

a. Alignment of intake bore. Precise location of the drive-pawl positioning stop (P46-74) is mandatory to align the intake bore of the sampler valve so that the calibrated intake characteristics are maintained. Adjustment of this stop to realign the intake bore is required only rarely. With the valve in the open position, the bore is aligned by loosening the pawl-positioning stop screw (P46-75) and sliding the stop in the proper direction until the intake bore of the valve plug is in perfect alignment with the corresponding passageway through the valve body. The location of the positioning stop is then secured by firmly tightening the stop screw. Alignment can be inspected by sighting through the intake passageway with the valve in the open position. The open position of the valve orients, simultaneously, passageways for admitting the sample into the bottle and for releasing air from the bottle. Sighting through the intake bore and sensing the ejection of air blown through the air escape port verifies the open position of the valve. If the intake passageway is open but air will not blow through the air escape passageway, the valve plug is out of orientation by 180 degrees. The position is corrected by rotating the valve plug one-half revolution and rechecking the alignment of intake and air exhaust passageways.

b. Valve-position-indicator switch. If the head cover is not removed or replaced carefully, the contact spring of the valve-position-indicator switch (shown on the indicator contact assembly detail on Fig. 7) may be bent or otherwise damaged. To adjust this spring, place the valve in the open position and bend the spring to make a firm contact, which completes the circuit to the meter and produces a deflection of the needle. Then check the meter with the valve in a position one ratchet tooth before and one after the fully open position to see if a reading is registered at these positions. Adjust the indicator switch spring to produce meter readings only at the fully open position.

42. Repairs--Major repairs to the instrument should be ordered through the District Engineer, U. S. Army Engineer District, St. Paul, Corps of Engineers, 1217 U. S. Post Office and Custom House, St. Paul 1, Minnesota. Defective instruments or assemblies to be repaired should be shipped to the address above. Spare parts are available to permit minor repairs in the field, or with the aid of a local machine shop. Construction plans and details are shown to a reduced scale in Fig 7 and 8 and full size copies are available to Federal Agencies by request to addressee above.

a. Failure of indicator batteries. If the indicator batteries fail and replacement is required before resupply can be procured from the above source, a suitable replacement can be assembled locally as follows:

(1) Penlight batteries. To replace the Penlight batteries use four (4) Penlight dry cell batteries Burgess No. 7, Ray-O-Vac No. 400 Size "K", Eveready No. 912, or equal, connected in series with soldered connections. This will form a power source of approximately 6 volts to which a 1000-ohm, one-half watt resistor is connected in series. The battery assembly should be wrapped into a compact package with protruding contact wires. To assure adequate duration of service, the package should be waterproofed by application of household wax, sealing compounds, plastic spray, dipping compounds, paint, or other similar products readily available. Installation is completed by connecting the negative lead from the battery to the indicator switch and the positive lead to the center conductor core or lead-in-wire from the switch box.

(2) Mercury batteries. To replace the Mercury batteries use three (3) each, RM3R or one (1) each (group of three) No. TR-233R Mallory Mercury "A" batteries, which furnishes 4 volts. The batteries are installed in a lucite box to form indicator battery assembly P46-87B shown on Fig. 7. A 1000-ohm, one-half watt resistor is connected in series with the batteries. The batteries are assembled so that the negative pole contacts the brass washer to which the contact spring of the indicator switch is soldered. When the end of the battery container box is screwed in place, the batteries must be pressed together sufficiently to insure positive pressure contacts at all electrical contact points. Poor contacts will result in unsatisfactory operation of the valve position indicator.

b. Burned micro-switch points. If an excessive voltage is delivered to the valve actuating mechanism, the points on the micro-switch may be burned, requiring frequent replacement of the switch. A 1 MFD capacitor across the common terminal and the normally open terminal of the micro-switch will minimize damage to the points.

43. Precautions--Although the rotary-solenoid mechanism is not unduly delicate, reasonable care must be exercised in connecting and operating it. The following precautions are recommended.

a. Check polarity. Failure to observe polarity markings will cause the meter to read backwards (see Section 38).

b. Check power. Always connect the battery end of the switch box to the battery, and the sampler end to the sampler (see Section 38). The meter may burn out if the connections are not made correctly.

c. Conserve indicator battery. Never leave the sampler with the valve in the open position because this places the indicator battery in the circuit and will discharge the battery. This can occur even when the control box is disconnected, because the indicator circuit is connected to the solenoid circuit. To conserve and prolong the life of these small batteries, the valve should be in the open position only while actually checking circuits or taking suspended-sediment samples.

d. Check valve operation and position. Before submerging the instrument make sure the open (sampling)position of the valve can be obtained by dialing the reference number.

e. Check electric connections. Be sure that all connections are clean and tight and that no bare wires are exposed to permit unintentional grounds or shorts in the electrical circuits.

f. Galvanic action. The bronze body of the sampler and the steel shield of the suspension cable when submerged in water may, if not properly connected, act as anode and cathode of a voltaic cell which can deliver about 1-1/2 volts to the meter. This voltage at the meter will cause the needle to deflect with sufficient force to bend it. Therefore, the outer shield of the suspension cable should be grounded to the sampler body so this voltage will not be delivered to the meter.

g. Protection of meter. The meter switch in the control box should never be depressed while the dial is being operated.

VIII. PROCEDURE FOR TAKING A SAMPLE

44. General comments on sampling--Normal sampling procedures are discussed here for some of the common types of samples. It may not always be necessary, and perhaps not always advisable, to take samples by a fixed procedure. Therefore, these procedures may be adjusted to meet special or local needs and conditions. The samples to be taken will depend on the purpose and scope of the individual investigation. The guiding principles should be set up by the field offices concerned. Although many of the points discussed here apply to any kind of suspended-sediment sampling, they apply specifically to sampling with the US P-46 sampler.

45. Sample container--A pint milk bottle of the round type is used as a sample container. The bottle must be clean before using. Suitable bottle caps or stoppers must be provided to keep dust out of the empty bottle, and to prevent contamination or loss of the sample.

46. Size of sample--The capacity of a sample bottle is about 470cc. The sampling time must be kept short enough so that the bottle is never filled above 450 cc or 5-1/4 in. Any sample greater than 440 cc may be suspected of being slightly in error. If a bottle is overfilled the sample should be discarded and another taken in a clean bottle. It is desirable to have samples of from 400 cc to 440 cc, or 4 to 5 in. in the bottle. However, a sample of 300 cc is probably satisfactory. If a sample is much too small, an additional sample may be taken in the same bottle in order to make up the desired volume, providing it is integrated similarly to the first sample. The limits of acceptable size of sample should never be so rigid that a large portion of the samples have to be taken over again. A minimum sample of 350 cc or 3 in. is suggested as acceptable.

It is desirable to have all samples about the same size because it is much easier and quicker to weigh a series of samples of uniform size. Probably there is also a smaller chance of making undiscovered errors in reading and recording weights if the samples are of uniform size. The larger the sample, the smaller will be the percentage error involved in some of the inherent inaccuracies in the reading of balances.

47. Sampling time--The size of the sample taken with a given sampler depends mainly on the velocity of the stream at the sampling point and on the length of sampling time. Since the velocity cannot be controlled, the size of sample is regulated by the length of time during which the sample is taken.

Curves in Fig. 9 show the relation between stream velocity and the corresponding time required for collecting a sample of 400 cc with nozzles of 1/8 in., 3/16 in. and 1/4 in. diameter. The 3/16 in. nozzle is the one with which the US P-46 sampler is normally equipped. These curves are based on the assumption that the velocity in the nozzle is the same as that in the stream at the point at which the sample is taken. Changes in temperature, and other factors, may cause small deviations from this relationship, but any large departure indicates that something is wrong with the sampler or with the sampling procedure. Any departure as great as 15% from the given figures for stream velocities over one ft. per sec. should be questioned. At velocities of less than one ft. per sec. larger percentage variations are to be expected.

If the stream velocity at the sampling point or in the stream vertical is known, the time required to take a sample of 400 cc may be found from Fig. 9. This time may be used for the first sample. If the first sample is smaller than desired, the next sampling time can be increased in proportion to the increase desired in the size of the sample. To decrease the size of the next sample the time should be decreased.

When the stream velocity is not known, it may be estimated either from previous experience, or by comparision with the known velocity at an adjacent sampling point. The estimated sampling time may be used on the first try, and either increased or decreased on the second try. It is better to underestimate the required sampling time than to overestimate it. If the sample bottle is completely filled there is no way to determine the error in the estimated time.

Because the instantaneous velocity fluctuates about the mean value at any point in a stream, there will be corresponding fluctuations in the size of sample collected. These variations in size will be greater for turbulent streams. The variations in sample size will tend to be smaller for samples taken over longer periods of time.

48 Information to be recorded--All pertinent information must be recorded for every sample. An area on the sample bottle may be frosted to give a suitable surface upon which to write. In this case all necessary information may be written on the bottle, or the bottle may be numbered or otherwise identified and the information recorded in a notebook. If the bottle is not frosted, the information pertaining to the sample or a sample identification number may be placed on the cap or on a gummed label which is attached to the side of the bottle.

A duplicating field book may be used to record pertinent information, including the sample identification number. The original copy of the field book record is sent to the laboratory with the sample while the duplicate is retained in the field book.

Complete records must be made in such a way that there will be the least possible chance of the information being lost or of the sample bottles being mixed up. The following information should always be recorded:

Name of the stream.
Location on the stream (precise).
Location across the width of the stream.
Depth or range in depth at which the sample was taken.
Stage of the stream (gage height on a permanent gage if available).
Date.
Time of day.
Party taking the sample.
Nozzle size.
Water temperature.
Number of the individual sample.

49. Point samples--A point sample is taken at one point in the cross-section of a stream. The sample is integrated over the duration of the sampling time. Point samples are taken at several selected points in the stream cross-section to provide complete information on the distribution of sediment.

a. With spring-driven valve. Point samples are taken with the clock-type-spring-driven sampler as follows:

(1) Remove the socket screw in the sampler head cover.

(2) Insert the socket wrench in the socket screw hole and engage it securely in the socket wrench recess in the valve plug.

(3) Wind clockwise until the valve spring is tight, and leave the wrench in place.

(4) Make one contact of the electrical switch and release--the valve should turn 1/3 revolution as shown by the socket wrench.

(5) Check whether the intake is open (blow through it or pass a pipe cleaner through, or if the head is raised look through).

(6) If the intake was not open, close the switch an instant and check again.

(7) If still not open, close the switch again and check the third time.

(8) When the open position of the valve has been found in this manner, wind the valve spring up 1/3 turn. This places the valve in the equalizing position. Later when the valve is tripped once the intake will be open. (Step 12)

(9) Remove the socket wrench and replace the socket screw.

(10) Insert a clean sample bottle and close down the sampler head.

(11) Lower the sampler to the point in the stream at which the sample is to be taken.

(12) Make one contact of the switch and open again, noting the time at which the switch was closed as that is the time sampling starts.

(13) When the desired sampling time has elapsed, close the switch, then open it again. The sampling time ends with the closing of the switch, which closes the sampler valve.

(14) Raise the sampler for the purpose of removing the sample.

(15) Depress the catch and raise the sampler head.

(16) Remove the sample bottle being careful not to spill the sample nor allow it to be contaminated.

(17) Place a cap on the bottle and record all necessary information concerning the sample.

b. Subsequent point samples are taken with the clock-type-spring-driven sampler as follows, providing the valve has not been moved from the closed position:

(1) Insert a clean sample bottle and close down the sampler head.

(2) Make one short contact of the switch to rotate the valve from the fully closed to the equalizing position.

(3) Follow items (11) - (17) of the procedure in section 49a for taking a point sample.

(4) After four or five samples have been taken, the valve spring will need to be rewound. To rewind and take the next sample, follow the procedure outlined in items (1) - (17) in Section 49a for taking a point sample.

c. With rotary-solenoid operated valve. Point samples are taken with the rotary-solenoid operated sampler as follows:

(1) Check all electrical connections.

(2) Dial the reference number (5 or 6) as shown inside the control box.

(3) Check for open position of valve by pressing the button in the control box and watching for deflection of the meter needle.

(4) If needle is not deflected, dial a second time and check meter. Dial a third time if necessary.

(5) If meter needle is not deflected with the third trial, dial the reference number minus one and check the meter repeatedly until the reading indicates that the valve is in the open position.

(6) Now dial the reference number two times to place the valve in the equalizing position

(7) Insert a clean sample bottle and close the sampler head.

(8) Lower the sampler to the point in the stream at which the sample is to be taken.

(9) Dial the reference number and note the time, which is the time sampling starts.

(10) Press the button in the control box and watch for deflection of the meter needle which indicates the valve is open.

(11) If the needle does not deflect, the valve is not open and steps must be repeated starting with item (5) above.

(12) When the desired sampling time has elapsed, dial the reference number again to close the valve. Note the time at which the sampling period ends.

(13) Raise the sampler.

(14) Depress the catch and raise the sampler head.

(15) Remove the sample bottle being careful not to spill the sample nor allow it to be contaminated.

(16) Place a cap on the bottle and record all necessary information concerning the sample.

d. Subsequent point samples are taken with the rotary-solenoid sampler as follows:

(1) Insert a clean sample bottle and close down the sampler head.

(2) Dial the reference number to move the valve from the closed to the equalizing position.

(3) Follow items (7) - (16) of the procedure in Section 49c for taking a point sample.

50. Composite samples--It is possible to combine two or more small samples in one bottle. The sampling time for each portion of the composite sample must be such that the total time will give the desired quantity of sample. If equal weight is to be given to each portion, the sampling time for each should be equal.

The procedure for combining three or four samples is similar to that for combining two samples and may be accomplished by following the outline below.

a. With the spring-operated valve. A composite sample may be taken with the spring-operated sampler as follows:

(1) The procedure given in Section 49a, items (1) - (13), should be followed to take the first portion of a composite sample.

(2) Next, make one short contact of the switch to rotate the valve from the fully closed to the equalizing position in preparation for taking the next portion of the composite sample.

(3) The next portion of the composite sample is then taken by following the procedure given in items (11) - (13) of Section 49a.

(4) The valve must be rotated from the closed position to the equalizing position by one short contact of the switch in preparation for taking another portion of the composite sample.

(5) The final portion of the composite sample is taken by following the procedure given in items (11) - (17) of Section 49a.

b. With the rotary-solenoid operated valve. A composite sample may be taken with the rotary-solenoid sampler as follows:

(1) The procedure given in Section 49c, items (1) - (12), should be followed to take the first portion of a composite sample.

(2) To take the next portion of a composite sample, first change the valve from the closed position to the equalizing position by dialing the reference number once, then follow the procedure given in items (8) - (12) of Section 49c.

(3) To take the final portion of the composite sample, dial the reference number to move the valve from the closed position to the equalizing position and then follow the procedure given in items (8) - (16), Section 49c.

51. Depth-integrated samples--Depth-integrated sediment samples may be taken with the point sampler by traversing the sampler over the range in depth to be sampled, while the valve is in the open position. Samples may be integrated between any given limits of depth provided the distance is not so great that an excessive rate of travel is required by the sampler to prevent overfilling the bottle. Depth-integrated samples may be taken (1) by continuous sampling from the surface to the

bottom and back to the surface of the stream, when the depth and/or velocity of flow is not too great; (2) by integration one way, either from the surface to the bottom or from the bottom to the surface when depth and/or velocity is beyond the range of two-way integration; and (3) by integrating the depth in two or more portions when the depth and/or velocity is beyond the range of complete one-way integration. The limitations and procedures for depth-integration sampling are discussed as follows:

a. Limitations. To take a depth-integrated sample of the water-sediment mixture in a stream, the sampling operation must continue uninterrupted while the sampler is either lowered or raised at a uniform rate of speed through the desired range in depth. There are certain limitations on the rate of raising or lowering the sampler during integration. The obvious one is the physical limitation of the equipment and operator. If the equipment can move the sampler at a vertical speed of only two feet per second, that is, of course, the maximum sampler speed available. Also the sampler will not operate properly if the vertical speed is excessive in proportion to the stream velocity. Excessive vertical speeds may be avoided by remembering that the sampler can integrate in one direction to 30 ft. if the sample is 400 cc or more and to 24 ft. if the sample is 320 cc or more. Generally two-way integration at a uniform speed is allowable to 15 ft. of depth for a sample of 400 cc or over, and to 12 ft. of depth for a sample of 320 cc or over. Although these limits assume a fairly normal shape of the vertical velocity curve of the stream, they may be used with reasonable assurance that the allowable speed of the sampler will not be seriously exceeded.

b. Two-way integration in shallow streams with moderate velocity. If the flow velocity is low or moderate, streams up to 15ft. in depth may be sampled by integrating continuously from the surface to the bottom and back to the surface. The direction of travel of the sampler should be reversed as rapidly as possible at the bottom of the stream, or at the bottom of the integrated depth. If the bottom is reached in a shorter time than originally planned, because the actual lowering rate was too great the correct total sampling time can be attained by raising the sampler at a slightly slower speed than that used going down. Similarly, too slow a lowering speed may be corrected by bringing the sampler up at a slightly faster rate. However the sampler should be lowered at one uniform speed, rapidly reversed and raised at a uniform speed, which does not need to be exactly the same as the lowering speed. Changes in speed between the lowering and raising trips should be kept small if the depth is near the maximum allowable for the resulting size of sample. A method for two-way integration is outlined as follows:

(1) Measure the stream depth at the sampling vertical by lowering the sampler from the surface to the bottom (before inserting a bottle) noting the reading on the depth indicator on the reel at both the surface and the bottom.

(2) After measuring the stream depth, retrieve the sampler.

(3) The sampler valve should be set in the open position and left there.

(4) A clean sample bottle must be placed in the sampler and the sampler head closed.

(5) The length of time required to obtain a sample of about 400 cc or to fill the bottle about 4 inches should be estimated based on stream velocity and Fig. 9.

(6) The rate at which the sampler is to be moved may be obtained by dividing twice the depth by the estimated time of sampling.

(7) Lower the sampler from above the water surface to the bed of the stream at the predetermined rate.

(8) Note the time at which the sampler enters the water.

(9) Rapidly reverse the direction of travel when the sampler reaches the bottom as indicated by the reading on the depth indicator and raise the sampler to the surface at the same rate. Care must be taken not to drop the sampler on the stream bed because this may cause the nozzle to dig into the bed and pick up bed material which will contaminate the sample.

(10) Note the time at which the sampler clears the water surface. It can then be raised for the removal of the sample.

(11) Remove the sample bottle, being careful not to spill or contaminate the sample.

(12) Cap the bottle and record all necessary information.

c. One-way integration in deep streams or streams of moderate depth with high velocity. If the depth of the stream is greater than 15 feet but less than 30 feet or the stream velocity is so great that unreasonably fast speed is required to lower and raise the sampler to prevent overfilling the bottle, then the sample should be obtained by depth integration in one direction only. Integration may be either from the surface to the bottom or from the bottom to the surface at a uniform speed through the range of depth. There are no data to prove that the direction of integration appreciably affects the accuracy of the results. Methods for integrating in either direction with either the spring operated sampler or the rotary solenoid operated sampler are outlined below.

d. Integrate from the surface to the bottom of a stream with the spring-operated sampler as follows:

(1) Follow the procedure in items (1) through (7), Section 49a, for taking a point sample.

(2) The valve is to be left in the open position.

(3) Remove the socket wrench and replace the socket screw.

(4) Insert a clean sample bottle and close down the sampler head.

(5) The time necessary to take a sample of about 400 cc or to fill the bottle about 4 inches should be estimated.

(6) The rate at which the sampler is to be lowered is obtained by dividing the depth to be integrated by the sampling time.

(7) Lower the sampler to the bottom of the stream at this rate.

(8) Note the time the sampler enters the water.

(9) The instant the sampler touches the bottom make one contact of the switch to close the sampler valve and open the switch again.

(10) Note the time at which the valve is closed.

(11) Raise the sampler.

(12) Remove the sample bottle being careful not to spill or contaminate the sample.

(13) Cap the bottle and record all necessary information

(14) To take subsequent samples insert a clean sample bottle and close down the sampler head.

(15) Make two short contacts of the switch to rotate the valve from the fully closed to the equalizing position and then to the open position (check to be sure the valve is open).

(16) Follow items (5) through (13) of the procedure above to obtain the second sample.

(17) After four or five samples have been taken, the valve spring will need to be rewound. To rewind and continue sampling, follow the procedure outlined in items (1) through (13) above.

e. Integrate from the bottom to the surface of a stream with the spring-operated sampler as follows:

(1) Follow items (1) through (10), Section 49a, for taking a point sample.

(2) Estimate the time necessary to take a sample of about 400 cc, or to fill the bottle 4 inches.

(3) The rate at which the sampler is to be raised is obtained by dividing the depth to be integrated by the sampling time.

(4) Lower the sampler to the bottom of the stream.

(5) Make one contact of the switch and open again to place the valve in the sampling position.

(6) Note the time the switch was operated.

(7) At the same time the contact is made, start raising the sampler at the rate determined under (3) above.

(8) Note the time when the sampler emerges from the water surface.

(9) Raise the sampler and remove the sample bottle being careful not to spill or contaminate the sample.

(10) Cap the bottle and record all necessary information.

(11) To take subsequent samples insert a clean sample bottle and close down the sampler head.

(12) Make two short contacts of the switch to rotate the valve from the open position to the fully closed position, and then to the equalizng position.

(13) Follow items (2) through (10) above to obtain the subsequent samples.

(14) After four or five samples have been taken, the valve spring will need to be rewound. The procedure for rewinding and for taking the next sample is given in Section 51e, items (1) through (10) above.

f. <u>Integrate from the surface to the bottom of a stream with the rotary-solenoid-operated sampler as follows:</u>

(1) Follow the procedure in items (1) to (5), Section 49c, for taking a point sample.

(2) The valve is to be left in the open position.

(3) Proceed as outlined in Section 51d, items (4) through (13), except in item (9) to close the sampler valve dial the reference number the instant the sampler touches the bottom of the stream.

(4) To take subsequent samples, insert a clean sample bottle and close down the sampler head.

(5) Dial the correct number two times to rotate the valve from the fully closed to the equalizing position and then to the open position.

(6) Proceed as in Section 51f, item (3), above.

g. <u>Integrate from the bottom to the surface of a stream with the rotary-solenoid-operated sampler as follows:</u>

(1) Follow items (1) through (7) Section 49c for taking a point sample.

(2) Proceed as outlined in Section 51e, items (2) through (10) except in item (5) dial the reference number to open the valve while the sampler is at the bottom of the stream.

(3) To take subsequent samples, insert a clean sample bottle and close down the sampler head.

(4) Dial the reference number two times, to move the valve from the open position to the closed and then to the equalizing position in preparation for lowering the sampler to the bed of the stream.

(5) Proceed as in Section 51g item (2) above.

h. Fractional depth integration in extremely deep streams or streams with very high velocity. Streams which are too deep or flow too fast to be depth integrated by the methods given above may be sampled by dividing the vertical into fractions each of which is depth integrated individually. The top half of the depth may be integrated as one sample and the bottom half as a second sample. In the same manner, the depth may be divided into thirds. If the individual samples are to be combined to give a representative sample for the total depth, the rate of sampler movement must be the same for all samples, and it must be uniform throughout the total depth. The entire depth must be integrated without skipping or overlapping any portion of the depth. Integration will be assumed to occur in one direction only. If the rate of sampler movement varies in each portion, each sample must be weighted according to the depth and velocity to which it pertains. After the individual samples have been properly weighted, the results may be combined to give a figure representative of the total depth.

(1) Divide the total depth into fractions. The surface velocity of the stream and the total depth are used to determine the rate at which the sampler will have to be raised or lowered and the number of parts into which the vertical must be divided. From Fig. 9 find the filling time for a sample of about 400 cc using the surface velocity and size of nozzle in the sampler. Divide the total depth to be integrated by this sampling time, to find the rate of sampler movement required to take the entire sample in one bottle. The maximum rate for moving the sampler is about 2 feet per second. If the

computed rate is too fast for handling the sampler (greater than 2 feet per second), but less than twice too fast, divide the total depth into halves. If the rate is more than twice too fast but less than three times too fast, divide the total depth into thirds.

(2) To sample fractional depth when divided into thirds. In this procedure the sampler should be moved at one-third the rate that was computed above for the total depth. The method for taking a sample from the surface to the bottom has already been given in Section 51d and 51f. This method may be used for sampling from the surface down to the third point of the depth by closing the sampler valve at the instant the sampler is lowered past this third point. Similarly, the method for taking a sample from the bottom to the surface, as given in Section 51e and 51g, may be adapted to taking a sample from the bottom up to the third point. In this case, the sampler valve is closed as the sampler passes the third point from the bottom.

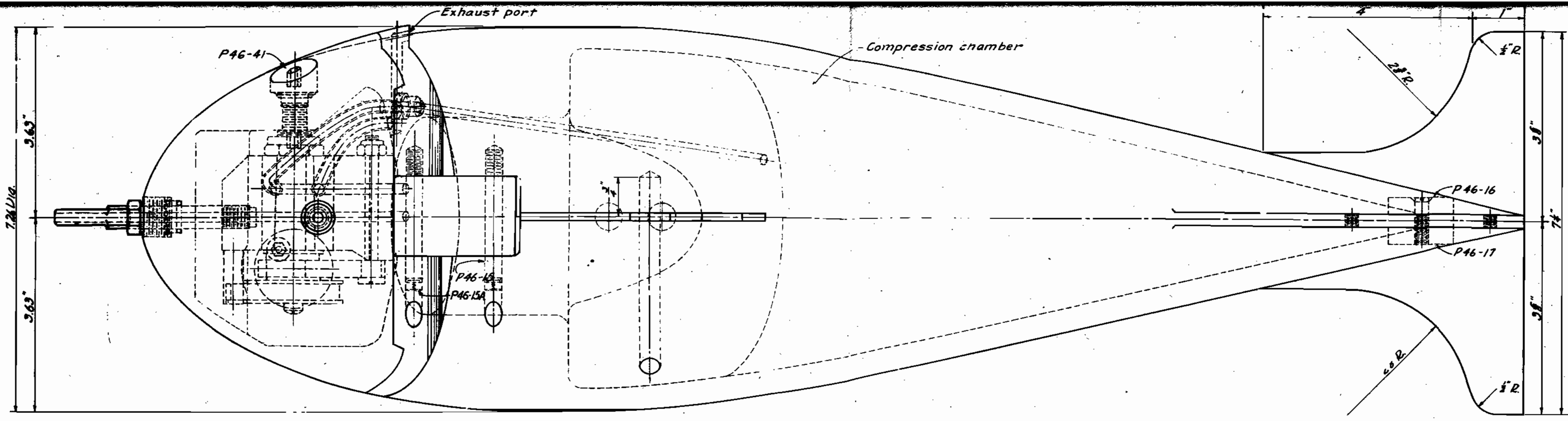
The middle third of the vertical remains to be sampled. This is where depth integration begins below the water surface and ends below the surface. The point sampling procedure, as given in Section 49a and 49c, may be followed, noting that the contact to open the sampler valve and start sampling is made at the time the sampler starts through the section of depth to be integrated; likewise, that the contact to close the valve and end sampling is made as the sampler reaches the limit of the portion of the depth to be integrated. In the period between these contacts, the sampler is moving at a uniform rate of speed through that fraction of the depth which is to be integrated. This rate is the same as that used for the top and bottom thirds of the depth.

52. Effect of downstream drift of the sampler--When sampling in high velocities by the depth-integrating method as discussed in Section 51, the sampler drifts downstream after entering the water. This has been generally ignored in the previous discussions. However, it does result in some sampling errors. First, there is the discrepancy between the depth as indicated by the amount of sampler suspension cable let out and the true vertical depth. Also, there is the fact that as the sampler is lowered into the stream, it continually drifts farther downstream. As it is raised to the surface, it is pulled upstream against the current. This results in an actual velocity past the sampler nozzle which is less than the stream velocity when the sampler is being lowered and greater than the stream velocity when the sampler is being raised. The scope of these instructions is too

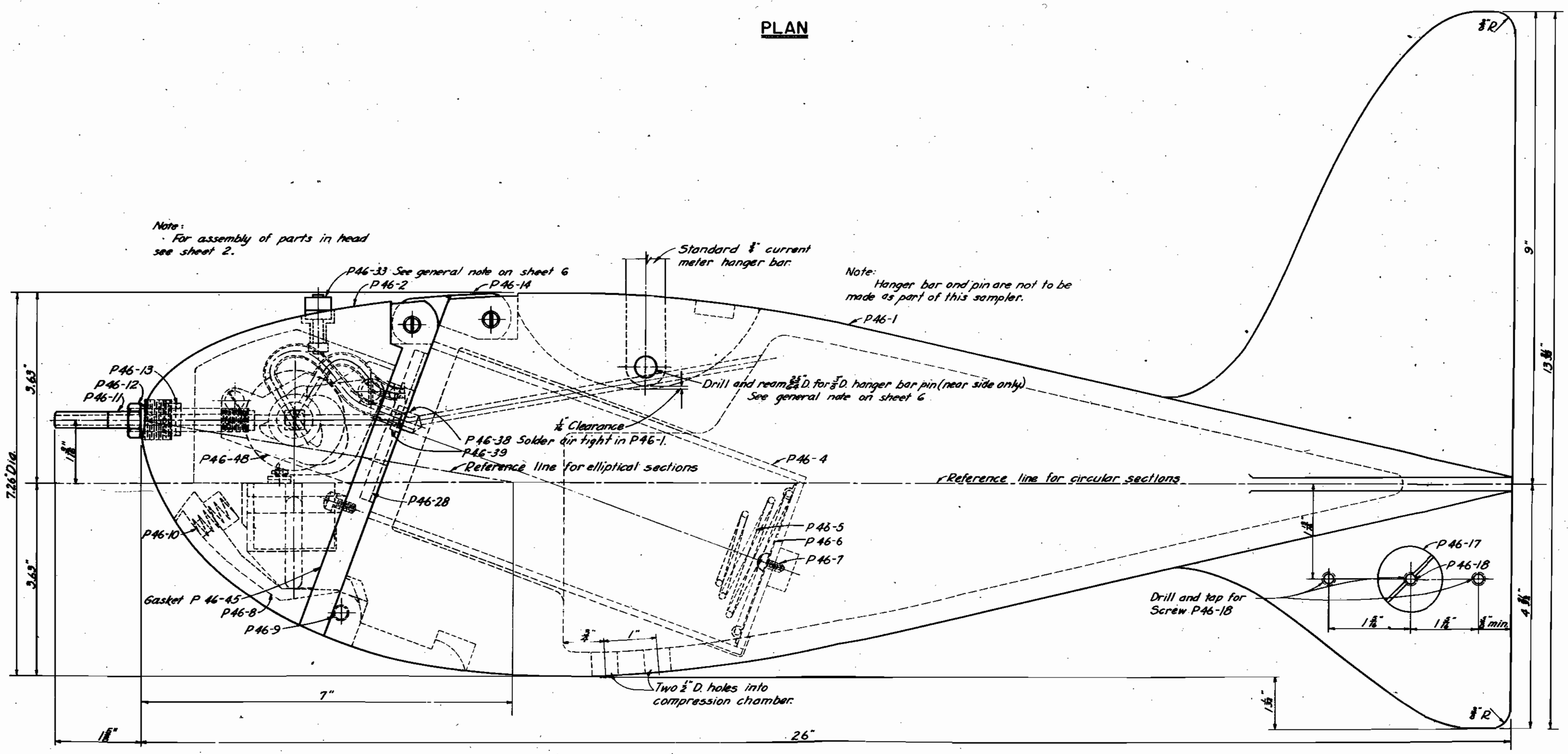
limited to attempt to explain the principles involved, and to indicate the corrections to apply to even the most usual conditions of downstream drift of the sampler. However, if the sampling instructions previously given are followed carefully, the errors arising from the downstream drift of the sampler will seldom be serious.

The most critical downstream drift conditions occur when the sampler is suspended from a point high above the water surface in a stream having a high velocity. If the product of the height of suspension of the sampler above the water in feet and the vertical angle of the sounding line in degrees exceeds 250, the US P-46 should not be used for two-way integration without a careful investigation of the probable errors involved.

In any comparison of sample quantity with stream velocity or of point samples with depth-integrated samples, the differences arising from the downstream drift of the sampler must be taken into account.



PLAN



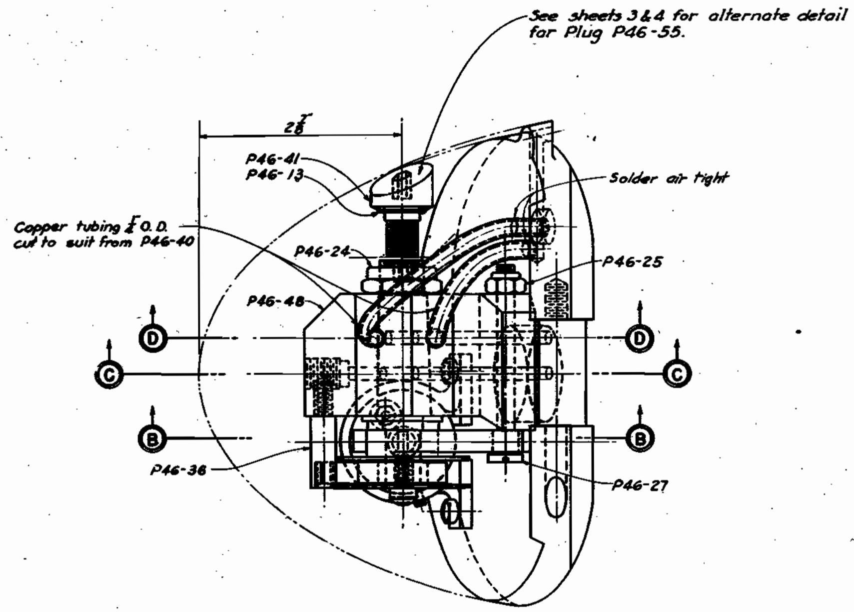
ELEVATION

GENERAL NOTE:
The Point-Integrating Suspended Sediment Sampler US P-46 was developed under the direction of the Interdepartmental Committee on a "STUDY OF METHODS USED IN MEASUREMENT AND ANALYSIS OF SEDIMENT LOADS IN STREAMS." The Committee was composed of representatives of Corps of Engineers, Soil Conservation Service, Geological Survey, Tennessee Valley Authority, Bureau of Reclamation, Office of Indian Affairs and Iowa Institute of Hydraulic Research.

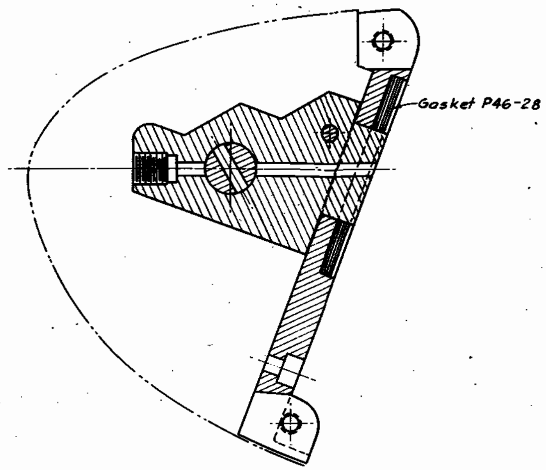
FEDERAL INTER-AGENCY SEDIMENTATION PROJECT

US P-46

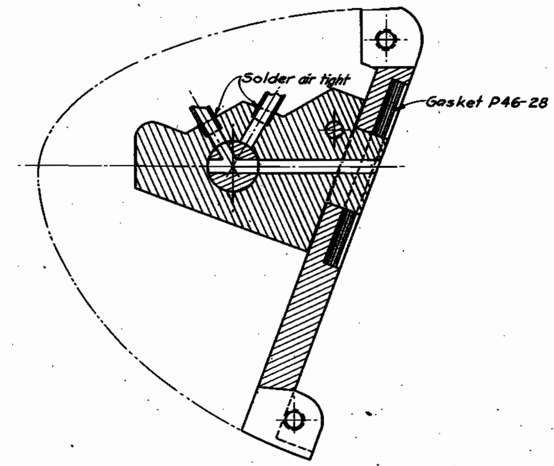
SUSPENDED SEDIMENT SAMPLER



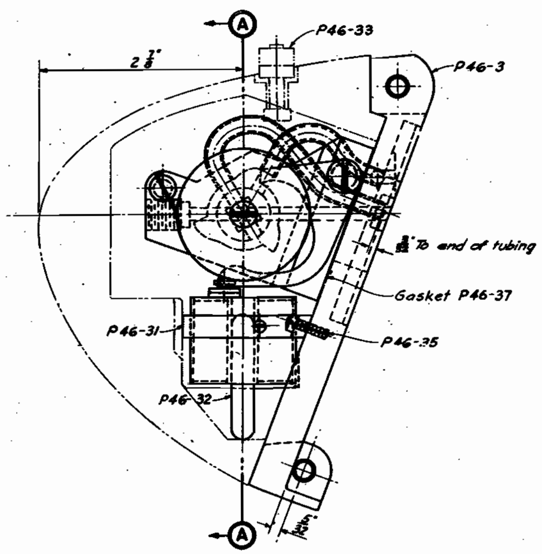
PLAN



SECTION C-C

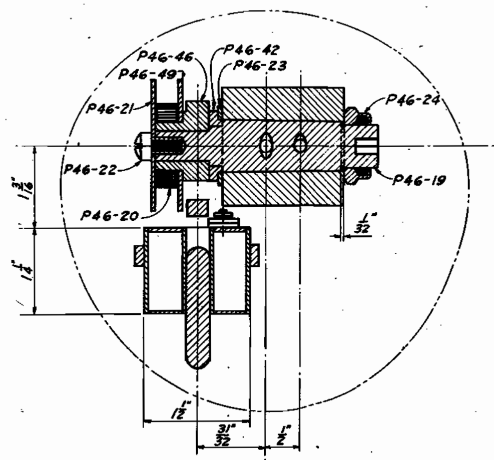


SECTION D-D

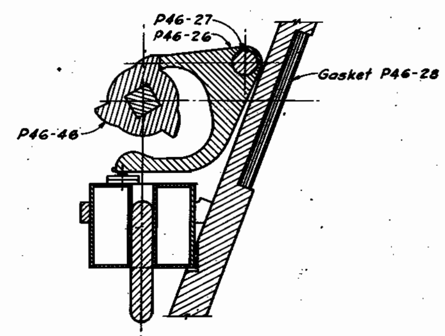


ELEVATION

VALVE MECHANISM



SECTION A-A



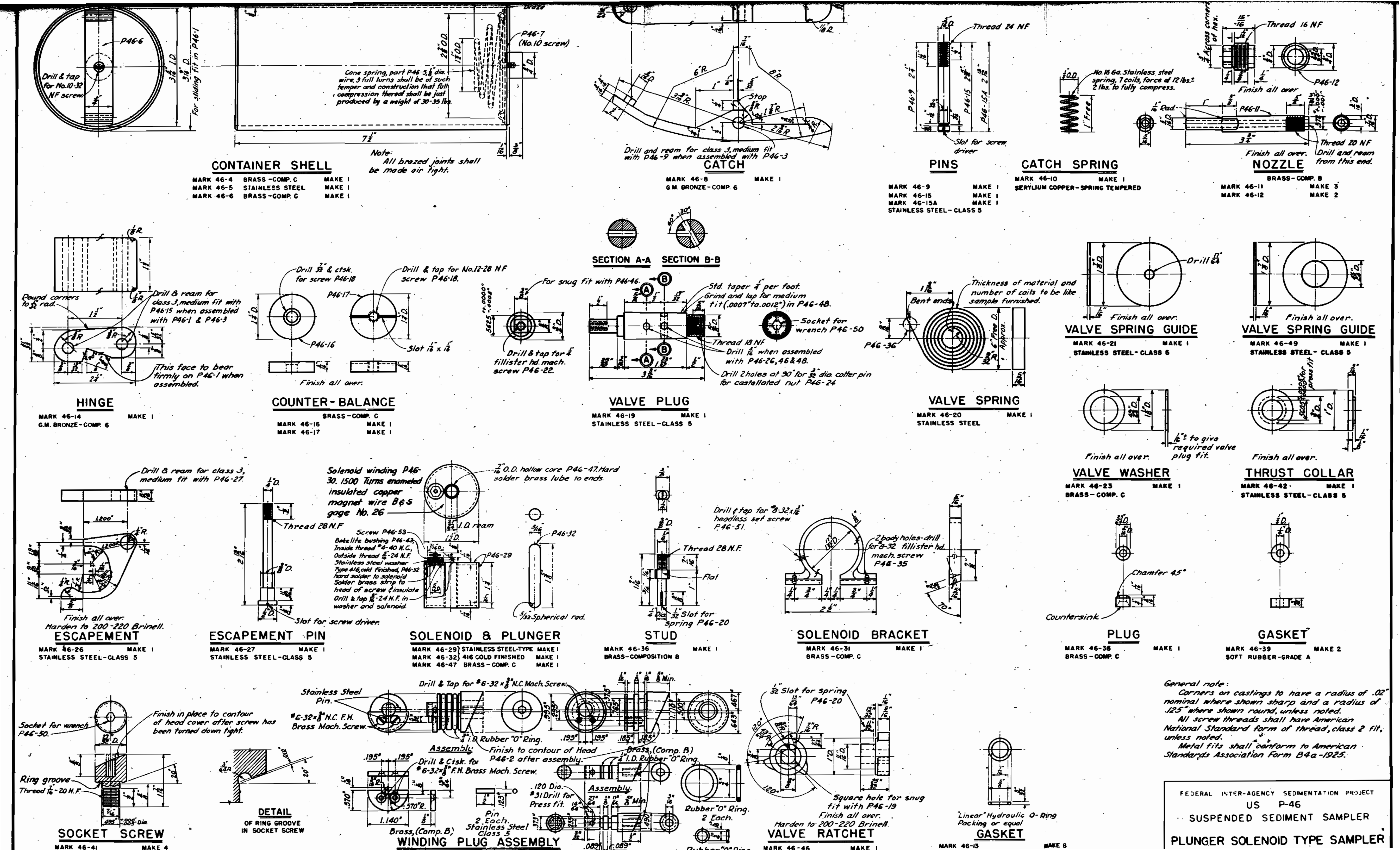
SECTION B-B

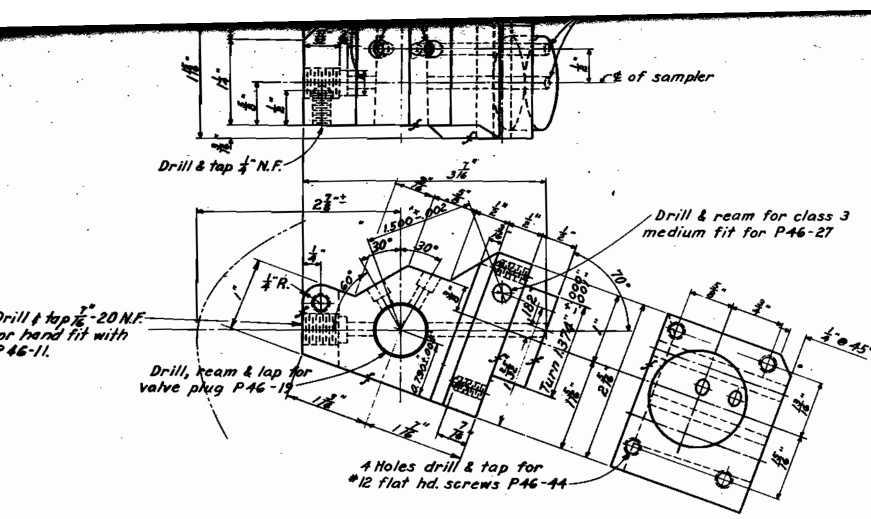
FEDERAL INTER-AGENCY SEDIMENTATION PROJECT

US P-46

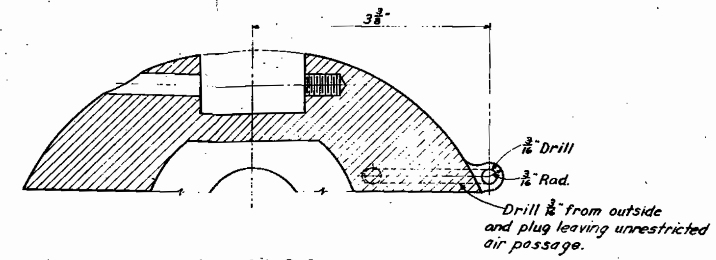
SUSPENDED SEDIMENT SAMPLER

PLUNGER SOLENOID TYPE SAMPLER

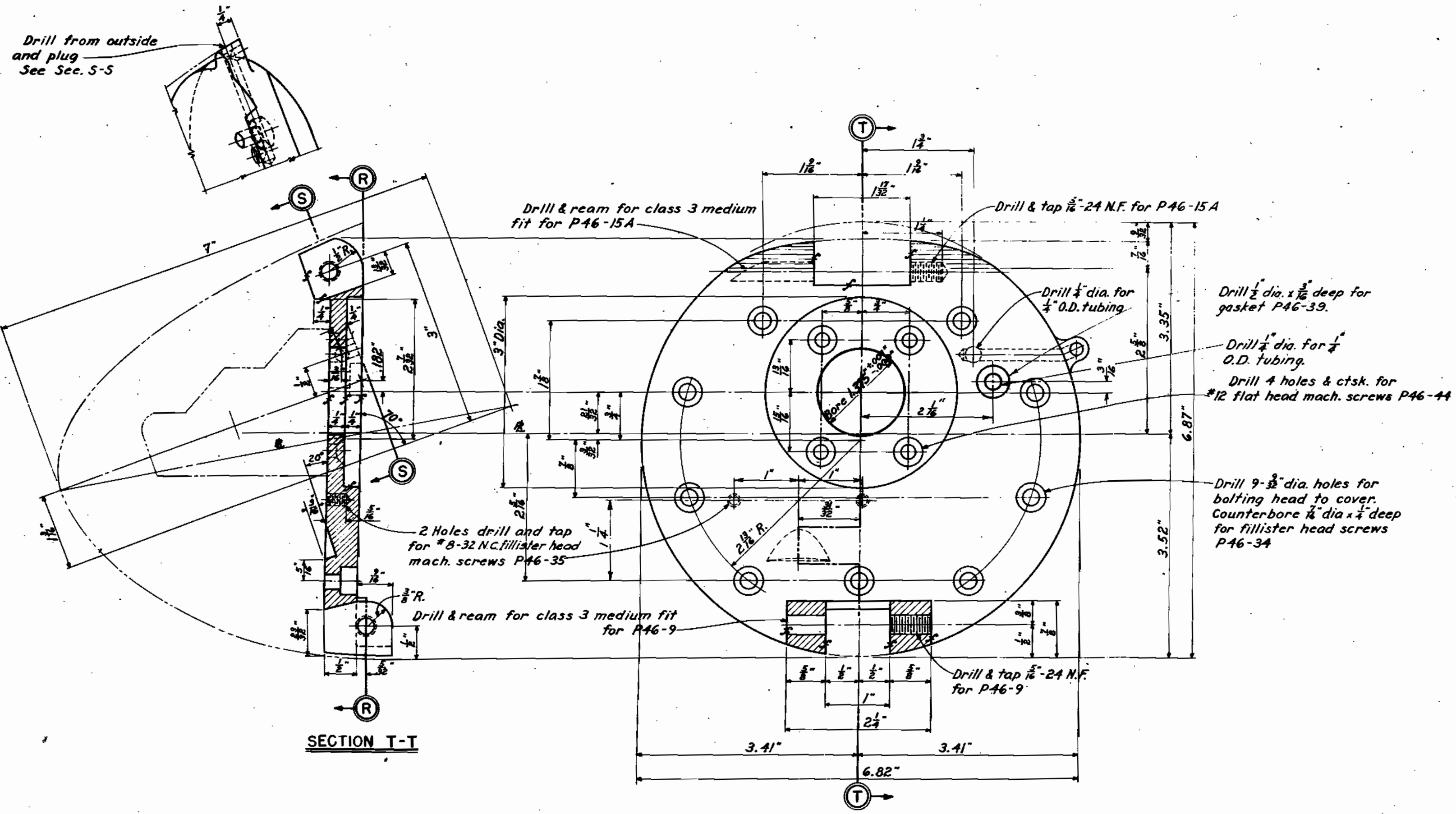

CONTAINER SHELL
MARK 46-4 BRASS-COMP. C MAKE 1
MARK 46-5 STAINLESS STEEL MAKE 1
MARK 46-6 BRASS-COMP. C MAKE 1
Drill & tap for No.10-32 NF screw
For sliding fit in P46-1
Cone spring, part P46-5, 1/8 dia. wire, 3 full turns shall be of such temper and construction that full compression thereof shall be just produced by a weight of 30-35 lbs.
P46-7 (No.10 screw)
Note: All brazed joints shall be made air tight.
CATCH
MARK 46-8 MAKE 1
G.M. BRONZE-COMP. 6
Drill and ream for class 3, medium fit with P46-9 when assembled with P46-3
PINS
MARK 46-9 MAKE 1
MARK 46-15 MAKE 1
MARK 46-15A MAKE 1
STAINLESS STEEL-CLASS 5
Thread 24 NF
Slot for screw driver
CATCH SPRING
MARK 46-10 MAKE 1
BERYLLIUM COPPER-SPRING TEMPERED
No.16 Ga. Stainless steel spring, 7 coils, force of 12 lbs.± 2 lbs. to fully compress.
NOZZLE
BRASS-COMP. B
MARK 46-11 MAKE 3
MARK 46-12 MAKE 2
Thread 16 NF
Finish all over
Thread 20 NF
Drill and ream from this end.
SECTION A-A
SECTION B-B
HINGE
MARK 46-14 MAKE 1
G.M. BRONZE-COMP. 6
Round corners to 1/32 rad.
Drill & ream for class 3, medium fit with P46-15 when assembled with P46-1 & P46-3
This face to bear firmly on P46-1 when assembled.
COUNTER-BALANCE
BRASS-COMP. C
MARK 46-16 MAKE 1
MARK 46-17 MAKE 1
Drill 3/32 & ctsk. for screw P46-18
Drill & tap for No.12-28 NF screw P46-18.
Finish all over.
VALVE PLUG
MARK 46-19 MAKE 1
STAINLESS STEEL-CLASS 5
For snug fit with P46-46.
Std. taper 1/4 per foot. Grind and lap for medium fit (.0007" to .0012") in P46-48.
Socket for wrench P46-50
Thread 18 NF
Drill 1/8 when assembled with P46-26, 46 & 48.
Drill 2 holes at 90° for 3/32 dia. cotter pin for castellated nut P46-24
Drill & tap for 1/4 fillister hd. mach. screw P46-22.
VALVE SPRING
MARK 46-20 MAKE 1
STAINLESS STEEL
Thickness of material and number of coils to be like sample furnished.
Bent ends
VALVE SPRING GUIDE
MARK 46-21 MAKE 1
STAINLESS STEEL-CLASS 5
VALVE SPRING GUIDE
MARK 46-49 MAKE 1
STAINLESS STEEL-CLASS 5
Finish all over.
VALVE WASHER
MARK 46-23 MAKE 1
BRASS-COMP. C
THRUST COLLAR
MARK 46-42 MAKE 1
STAINLESS STEEL-CLASS 5
ESCAPEMENT
MARK 46-26 MAKE 1
STAINLESS STEEL-CLASS 5
Drill & ream for class 3, medium fit with P46-27.
Finish all over. Harden to 200-220 Brinell.
ESCAPEMENT PIN
MARK 46-27 MAKE 1
STAINLESS STEEL-CLASS 5
Thread 28 N.F.
Slot for screw driver.
SOLENOID & PLUNGER
MARK 46-29 STAINLESS STEEL-TYPE MAKE 1
MARK 46-32 416 COLD FINISHED MAKE 1
MARK 46-47 BRASS-COMP. C MAKE 1
Solenoid winding P46-30. 1500 Turns enameled insulated copper magnet wire B&S gage No. 26
7/16 O.D. hollow core P46-47. Hard solder brass tube to ends.
5/32 Spherical rad.
STUD
MARK 46-36 MAKE 1
BRASS-COMPOSITION B
Thread 28 N.F.
Flat
Slot for spring P46-20
SOLENOID BRACKET
MARK 46-31 MAKE 1
BRASS-COMP. C
Drill & tap for 8-32 x 3/16 headless set screw P.46-51.
2 body holes-drill for 8-32 fillister hd. mach. screw P46-35
PLUG
MARK 46-38 MAKE 1
BRASS-COMP. C
Chamfer 45°
Countersink
GASKET
MARK 46-39 MAKE 2
SOFT RUBBER-GRADE A
SOCKET SCREW
MARK 46-41 MAKE 4
Socket for wrench P46-50.
Finish in place to contour of head cover after screw has been turned down tight.
Ring groove
DETAIL OF RING GROOVE IN SOCKET SCREW
WINDING PLUG ASSEMBLY
Stainless Steel Pin.
Drill & Tap for #6-32 x 3/8 N.C. Mach. Screw.
Rubber "O" Ring.
Finish to contour of Head P46-2 after assembly.
Brass, (Comp. B)
Assembly.
Pin 2 Each. Stainless Steel Class 5
VALVE RATCHET
MARK 46-46 MAKE 1
Slot for spring P46-20
Square hole for snug fit with P46-19
Finish all over.
Harden to 200-220 Brinell.
GASKET
MARK 46-13 MAKE 8
"Linear" Hydraulic O-Ring Packing or equal
General note:
Corners on castings to have a radius of .02" nominal where shown sharp and a radius of .125" where shown round, unless noted.
All screw threads shall have American National Standard form of thread, class 2 fit, unless noted.
Metal fits shall conform to American Standards Association Form B4a-1925.
FEDERAL INTER-AGENCY SEDIMENTATION PROJECT
US P-46
SUSPENDED SEDIMENT SAMPLER
PLUNGER SOLENOID TYPE SAMPLER



VALVE BODY
MARK P46-48 MAKE 1
G.M. BRONZE COMP. 6



SECTION S-S



SECTION T-T

SECTIONAL VIEW R-R

HEAD BASE
MARK P46-3 MAKE 1

P46-2	Head Cover	G.M. Bronze - Comp. 6	1	
P46-3	Head Base	G.M. Bronze - Comp. 6	1	
P46-4	Container Shell	Brass - Comp. C	1	
P46-5	Spring	Stainless Steel	3	Or Berylium copper Spring tempered
P46-6	Spring Holder	Brass - Comp. C	1	#16 B.&S. Gauge
P46-7	Screw-round hd. No. 10-32 N.F. $\frac{3}{8}$" lg.	Brass - Comp. B	1	
P46-8	Catch	G.M. Bronze - Comp. 6	1	
P46-9	Catch Pin	Stainless Steel-Class 5	1	
P46-10	Catch Spring	Stainless steel	3	Or Berylium copper spring tempered
P46-11	Intake Nozzle	Brass - Comp. B	3	Includes 2 spares
P46-12	Intake Nozzle Nut	Brass - Comp. B	2	Includes 1 spare
P46-13	Gasket	Synthetic rubber compound	8	Linear Hydraulic O-Ring Packing or equal
P46-14	Hinge	G.M. Bronze - Comp. 6	1	
P46-15 & 15A	Hinge Pins	Stainless Steel-Class 5	2	1 each
P46-16	Counterbalance	Brass - Comp. C	1	
P46-17	Counterbalance	Brass - Comp. C	1	
P46-18	Counterbalance Screw	Brass - Comp. B	1	No. 12 - flat head - 28 N.F. - $1\frac{3}{16}$" long
P46-19	Valve Plug	Stainless Steel-Class 5	1	
P46-20	Valve Spring	Stainless Steel	3	Or berylium copper, spring tempered
P46-21	Valve Spring Guide	Stainless Steel-Class 5	1	
P46-22	Valve Spring Guide Screw	Stainless Steel-Class 5	1	1/4"-Fillister hd. 28 N.F. - 1/2" long
P46-23	Valve Washer	Brass - Comp. C	1	
P46-24	Valve nut-Thin castellated	Brass	1	$\frac{5}{8}$" Thin S.A.E. Hex.
P46-25	Escapement Pin Nut Elastic Stop or equal	Brass	1	$\frac{1}{4}$" S.A.E. Std. Hex.
P46-26	Valve Escapement	Stainless Steel-Class 5	1	
P46-27	Valve Escapement Pin	Stainless Steel-Class 5	1	
P46-28	Sealing Gasket	Gum Rubber-soft-Grade A	2	3" O.D.-1 3/8" I.D. 3/16" thick Includes 1 spare
P46-29	Solenoid Housing	Stainless Steel-Type 416, cold finished	1	
P46-30	Solenoid Winding	Copper	1	
P46-31	Solenoid Bracket	Brass - Comp. C	1	
P46-32	Solenoid Plunger	Stainless Steel - Type 416 cold finished	1	
P46-33	Contact Post Assembly	Brass	1	
P46-34	Screw-$\frac{1}{4}$"-Fillister hd.-28 N.F.-$\frac{9}{16}$" lg.	Brass - Comp. B	9	
P46-35	Screw-No8 Fillister hd-32 N.C. 7/16 lg.	Brass - Comp. B	2	For Solenoid Br.
P46-36	Stud	Brass - Composition B or Stainless Steel - Class 5	1	For valve spring
P46-37	Gasket-between P46-3 & 48	Rubber-sheet packing	2	$\frac{1}{32}$" thick includes 1 spare
P46-38	Plug	Brass - Comp. C	1	
P46-39	Gasket	Rubber-soft-Grade A	2	Includes 1 spare
P46-40	Tubing-$\frac{1}{4}$" O.D., $\frac{3}{16}$" I.D., 9" long	Copper - Type N	1	
P46-41	Socket Screw	G.M. Bronze - Comp. 6	4	Includes 3 spares
P46-42	Thrust Collar	Stainless Steel-Class 5	1	
P46-43	Bushing	Bakelite	1	
P46-44	Screw-No. 12 flat hd.-28 N.F.-$\frac{3}{8}$" lg.	Brass - Comp. C	4	
P46-45	Gasket - between P46-2 and 3	Rubber-sheet packing	2	1/32" thick - see sheet 4 Includes 1 spare
P46-46	Valve Ratchet	Stainless Steel-Class 5	1	
P46-47	Solenoid Core	Brass - Comp. C	1	$\frac{7}{16}$" O.D.-$\frac{5}{16}$" I.D. x $1\frac{1}{4}$"
P46-48	Valve Body	G.M. Bronze - Comp. 6	1	
P46-49	Valve Spring Guide	Stainless Steel-Class 5	1	
P46-50	Socket Screw Wrench - Am. Std.	Steel	3	Hex. $\frac{7}{32}$" across flats
P46-51	Headless Set Screw-No8-32 x $\frac{5}{16}$" lg.	Stainless Steel	1	
P46-52	Washer-$\frac{7}{16}$ O.D.-1/4" I.D.-1/16" thick	Stainless Steel - Type 416 cold finished	1	
P46-53	Screw-No. 4 - Flat Hd-40 N.C. $\frac{5}{16}$" lg.	Brass - Comp. B	1	Brass nut $\frac{1}{16}$" thick
P46-54	Cotter Pin, 3/32 dia. min. length 1 5/8"	Brass	6	For Valve Nut 46-24
P46-55	Winding Plug Assembly	Brass - S.S. - Rubber	1	Alternate P46-41

General notes:

Drill and finish air exhaust as shown. Holes must line up so that a continuous passage of not less than $\frac{3}{16}$" in diameter is provided.

Intake hole through nozzle, valve body and valve plug must line up along one straight axis so that a continuous passage of not less than $\frac{3}{16}$" in diameter is provided.

The hole for the hanger bar pin shall be drilled at such a point that the intake nozzle and horizontal tail vanes will be horizontal when the sampler is suspended in water with counterbalance in the center position. See specifications.

Exterior surface of sampler shall be sanded smooth and buffed.

Weight of sampler is about 90 pounds.

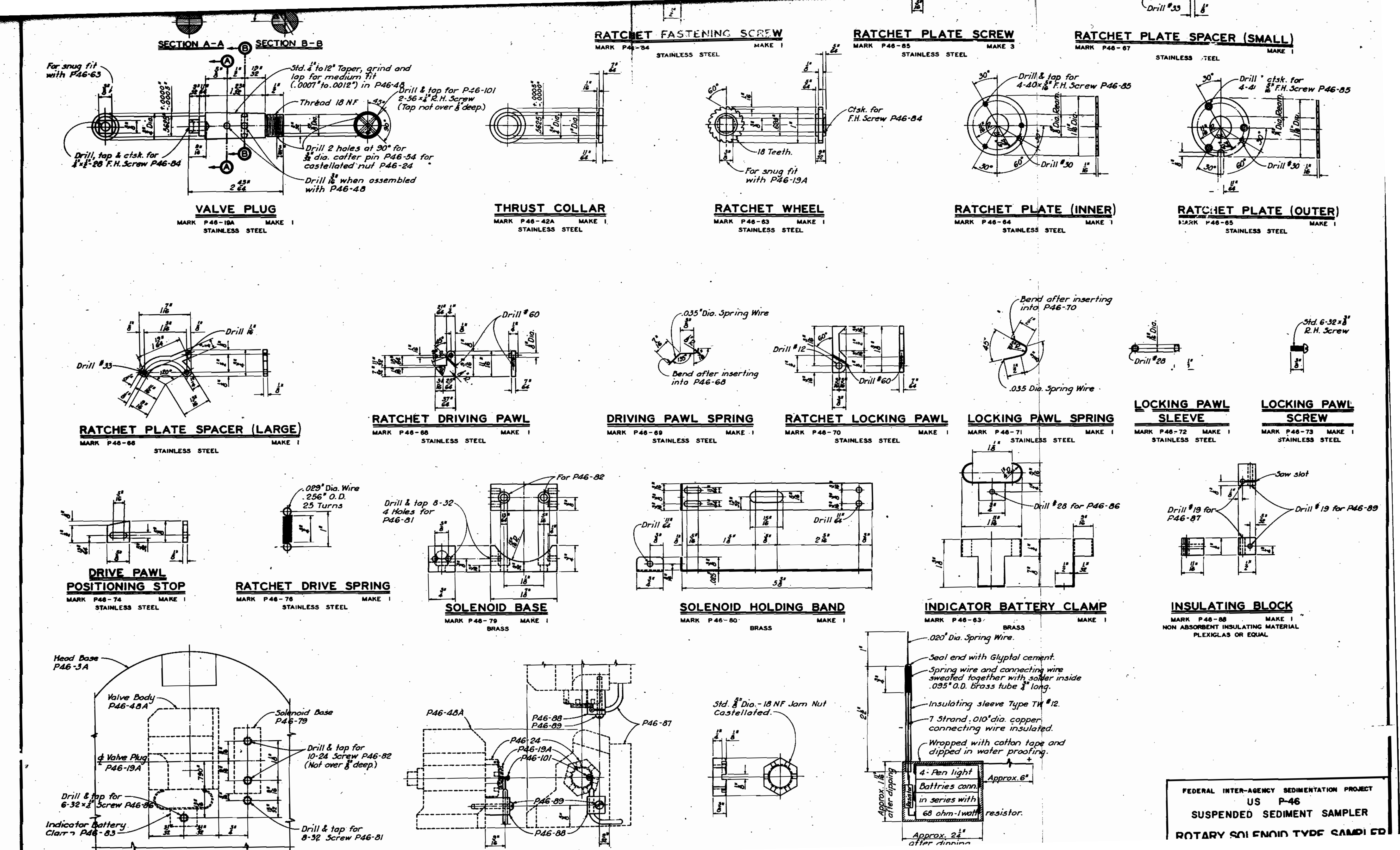
The contact post (P46-33) shall be insulated from the head cover and waterproofed to prevent leakage when submerged.

Corners on castings to have a radius of .02" nominal where shown sharp and a radius of .125" where shown round, unless noted.

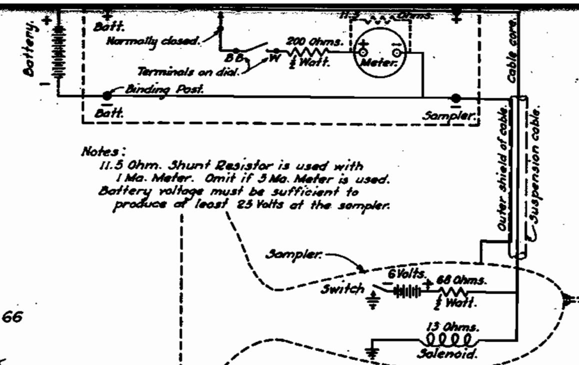
All screw threads shall have American National Standard form of thread, class 2 fit, unless noted.

Metal fits shall conform to American Standards Association Form B4a - 1925

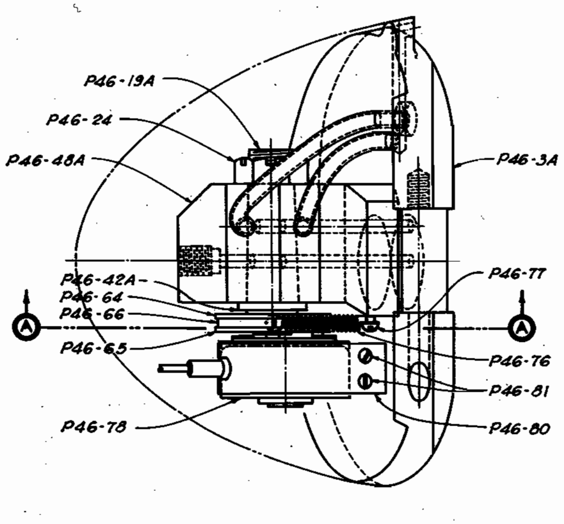
FEDERAL INTER-AGENCY SEDIMENTATION PROJECT
US P-46
SUSPENDED SEDIMENT SAMPLER
PLUNGER SOLENOID TYPE SAMPLER



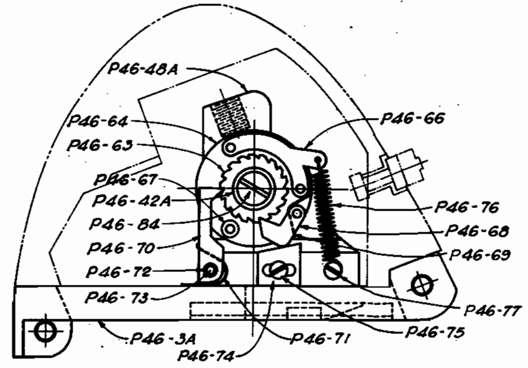
SECTION A-A
SECTION B-B
For snug fit with P46-63
Thread 18 NF
Drill & tap for P46-101
Drill, tap & ctsk. for F.H. Screw P46-84
Drill 2 holes at 90° for dia. cotter pin P46-54 for castellated nut P46-24
VALVE PLUG
MARK P46-19A MAKE 1
STAINLESS STEEL
THRUST COLLAR
MARK P46-42A MAKE 1
STAINLESS STEEL
RATCHET FASTENING SCREW
MARK P46-84 MAKE 1
STAINLESS STEEL
Ctsk. for F.H. Screw P46-84
18 Teeth.
For snug fit with P46-19A
RATCHET WHEEL
MARK P46-63 MAKE 1
STAINLESS STEEL
RATCHET PLATE SCREW
MARK P46-85 MAKE 3
STAINLESS STEEL
Drill #30
RATCHET PLATE (INNER)
MARK P46-64 MAKE 1
STAINLESS STEEL
RATCHET PLATE SPACER (SMALL)
MARK P46-67 MAKE 1
STAINLESS STEEL
Drill #33
Drill #30
RATCHET PLATE (OUTER)
MARK P46-65 MAKE 1
STAINLESS STEEL
Drill #33
RATCHET PLATE SPACER (LARGE)
MARK P46-66 MAKE 1
STAINLESS STEEL
Drill #60
RATCHET DRIVING PAWL
MARK P46-68 MAKE 1
STAINLESS STEEL
.035" Dia. Spring Wire
Bend after inserting into P46-68
DRIVING PAWL SPRING
MARK P46-69 MAKE 1
STAINLESS STEEL
Drill #12
Drill #60
RATCHET LOCKING PAWL
MARK P46-70 MAKE 1
STAINLESS STEEL
Bend after inserting into P46-70
.035 Dia. Spring Wire
LOCKING PAWL SPRING
MARK P46-71 MAKE 1
STAINLESS STEEL
Drill #28
LOCKING PAWL SLEEVE
MARK P46-72 MAKE 1
STAINLESS STEEL
LOCKING PAWL SCREW
MARK P46-73 MAKE 1
STAINLESS STEEL
DRIVE PAWL POSITIONING STOP
MARK P46-74 MAKE 1
STAINLESS STEEL
.029" Dia. Wire
.256" O.D.
25 Turns
RATCHET DRIVE SPRING
MARK P46-76 MAKE 1
STAINLESS STEEL
For P46-82
Drill & tap 8-32 4 Holes for P46-81
SOLENOID BASE
MARK P46-79 MAKE 1
BRASS
SOLENOID HOLDING BAND
MARK P46-80 MAKE 1
BRASS
Drill #28 for P46-86
INDICATOR BATTERY CLAMP
MARK P46-83 MAKE 1
BRASS
Saw slot
Drill #19 for P46-87
Drill #19 for P46-89
INSULATING BLOCK
MARK P46-88 MAKE 1
NON ABSORBENT INSULATING MATERIAL
PLEXIGLAS OR EQUAL
Head Base P46-3A
Valve Body P46-48A
Solenoid Base P46-79
Valve Plug P46-19A
Drill & tap for 10-24 Screw P46-82
Drill & tap for 8-32 Screw P46-81
Indicator Battery Clamp P46-83
P46-48A
P46-88
P46-89
P46-24
P46-19A
P46-101
P46-87
P46-89
P46-88
Castellated.
.020" Dia. Spring Wire.
Seal end with Glyptal cement.
Insulating sleeve Type TW #12.
connecting wire insulated.
Wrapped with cotton tape and dipped in water proofing.
4-Pen light Battries conn. in series with 68 ohm-1watt resistor.
Approx. 6"
FEDERAL INTER-AGENCY SEDIMENTATION PROJECT
US P-46
SUSPENDED SEDIMENT SAMPLER
ROTARY SOLENOID TYPE SAMPLER



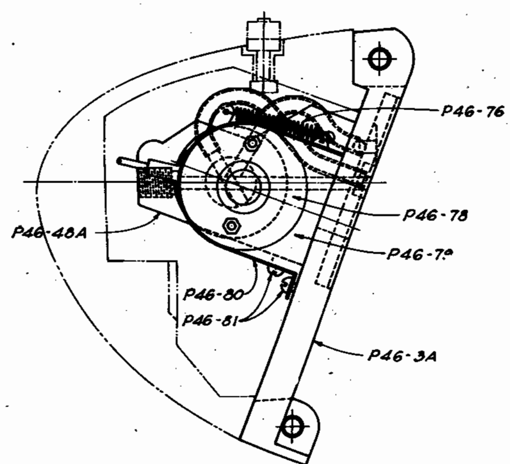
WIRING DIAGRAM



PLAN

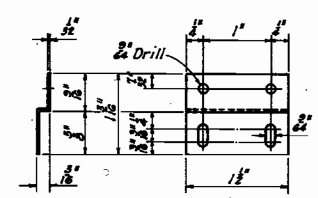


SECTION A-A



ELEVATION

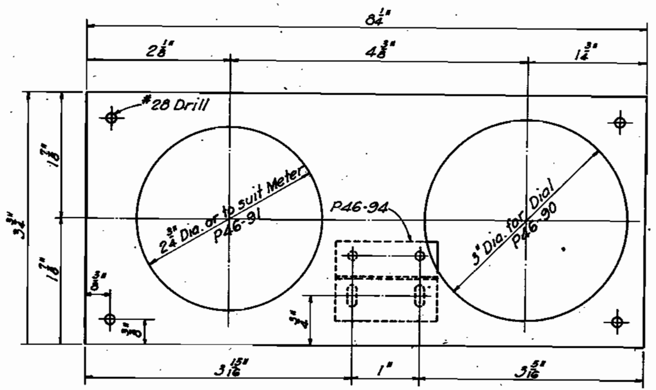
VALVE MECHANISM



MICRO SWITCH BRACKET

MARK P46-94 MAKE 1

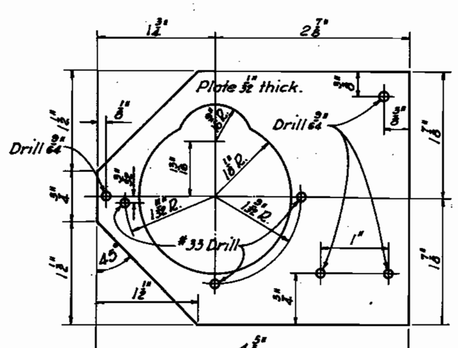
BRASS

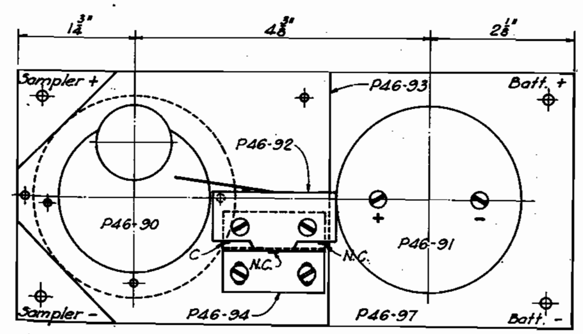


DIAL & METER PANEL

MARK P46-97 MAKE 1

3/4" PLYWOOD





REAR VIEW OF DIAL & METER PANEL

[illegible]	[illegible]	G.M. Bronze-6	1	
P46-2	Head Cover	" " "	1	
P46-3A	Head Base	" " "	1	
P46-4	Container Shell	Brass - C	1	
P46-5	Spring	Stainless Steel	1	Or Beryllium copper - Spring Temper
P46-6	Spring Holder	Brass - C	1	No. 16 B&S Gauge
P46-7	Screw - #10 R.H.-32 NF x 3/8" lg.	" - B	1	
P46-8	Catch	G.M. Bronze-6	1	
P46-9	Catch Pin	Stainless Steel-5	1	
P46-10	Catch Spring	Stainless Steel	1	Or Beryllium copper - Spring Temper
P46-11	Intake Nozzle	Brass - B	1	
P46-12	Intake Nozzle Nut	" "	1	
P46-13	Gasket	Synthetic Rubber	1	"Linear" Hydraulic O-ring or equal
P46-14	Hinge	G.M. Bronze-6	1	
P46-15	Hinge Pin	Stainless Steel-5	1	For P46-1
P46-15A	Hinge Pin	" " "	1	For P46-3
P46-16	Counterbalance	Brass - C	1	
P46-17	Counterbalance	" "	1	
P46-18	Counterbalance Screw	" - B	1	#12 F.H.-28 NF x 13/16" lg.
P46-19A	Valve Plug	Stainless Steel-5	1	
P46-24	Valve Plug Nut	Brass	1	Or Stainless Steel Shear Nut.
P46-28	Sealing Gasket	Gum Rubber-Soft	1	3" O.D.-1 7/8" I.D. x 5/16" thick.
P46-33	Contact Post Assembly	Brass-Plastic-Rubber	1	
P46-34	Screw - ¼" Fillister H.-28 NF x 9/16" lg.	Brass - B	9	Or Stainless Steel Socket Head Cap Screw With Key
P46-37	Gasket - between P46-3 & 48	Rubber - Sheet	1	1/32" Thick
P46-38	Plug	Brass - C	1	
P46-39	Gasket	Rubber-Soft-A	1	
P46-40	Tubing - ¼" O.D. x 3/16" I.D. x 9" lg.	Copper-Type N	1	
P46-42A	Thrust Collar	Stainless Steel-5	1	
P46-44	Screw - #12 F.H.-28 NF x 5/8" lg.	Brass - C	4	
P46-45	Gasket - between P46-2 & 3	Rubber - Sheet	1	1/32" Thick - see sheet 4
P46-48A	Valve Body	G.M. Bronze-6	1	
P46-54	Cotter Pin - 3/32" Dia. x 1 3/8" lg.	Brass	1	For P46-24
P46-63	Ratchet Wheel	Stainless Steel-5	1	
P46-64	Ratchet Plate (inner)	Stainless Steel	1	
P46-65	Ratchet Plate (outer)	" "	1	
P46-66	Ratchet Plate Spacer (large)	" "	1	
P46-67	Ratchet Plate Spacer (small)	" "	1	
P46-68	Ratchet Driving Pawl	Stainless Steel-5	1	
P46-69	Driving Pawl Spring	Stainless Steel	1	
P46-70	Ratchet Locking Pawl	Stainless Steel-5	1	
P46-71	Locking Pawl Spring	Stainless Steel	1	
P46-72	Locking Pawl Sleeve	" "	1	Or Brass
P46-73	Locking Pawl Screw	" "	1	Or Brass - #6 R.H.-32 NF x 3/8" lg.
P46-74	Drive Pawl Positioning Stop	Stainless Steel-5	1	
P46-75	Pawl Positioning Stop Screw	Brass	1	#6 R.H.-32 NF x 3/8" lg.
P46-76	Ratchet Drive Spring	Stainless Steel	1	Or Beryllium Copper - Spring temper (Gardner EGC) or equal.
P46-77	Drive Spring Screw	Brass	1	#6 R.H.-32 NF x 3/8" lg.
P46-78	Rotary Solenoid		1	LEDEX BDB3R3SEPT x 3x9" by G.H. LELAND INC. or equal.
P46-79	Solenoid Base	Brass	1	
P46-80	Solenoid Holding Band	"	1	
P46-81	Solenoid Band Screw	"	5	#8 R.H.-32 NF x ¼" lg.
P46-82	Solenoid Base Screw	"	2	#10 Fil. H.-32 NF x ¼" lg.
P46-83	Battery Clamp	"	1	
P46-84	Ratchet Fastening Screw	Stainless Steel	1	Or Brass ¼" F.H.-28 x ½" lg.
P46-85	Ratchet Plate Screw	" "	3	Or Brass #4 F.H.-40 NF x 5/16" lg.
P46-86	Battery Clamp Screw	Brass	1	#6 R.H.-32 NF x ¼" lg.
P46-87	Indicator Battery Assembly	See detail	1	
P46-88	Insulating Block	Non Absorbant Insulating Material	1	Plexiglas or equal
P46-89	Insulating Block Screw	Brass	1	#8 R.H.-32 NF x 1" lg.
P46-90	Dial		1	W.E.Co. Type 5HA3 or equal
P46-91	Meter - 0-5 MA - DC		1	0-1 Milliammeter D.C.
P46-92	Micro Switch		1	Type B2-2RLT or equal
P46-93	Dial Mounting Plate	Brass	1	
P46-94	Micro Switch Bracket	Brass	1	
P46-95	Binding Posts	Rubber	4	EBY Type 30 or equal
P46-96	Dial & Meter Case	Metal or ¼" Plywood	1	
P46-97	Dial & Meter Panel	¾" Plywood	1	
P46-98	Resistor - 200 ohm, ½ watt		1	
P46-99	Resistor - 68 ohm, ½ watt		1	
P46-100	Resistor - 11.5 ohm, wire wound		1	Installed only with 0-1 Ma. Meter
P46-101	Contact Screw	Brass	1	#2 R.H.-56 NF x ¼" lg.

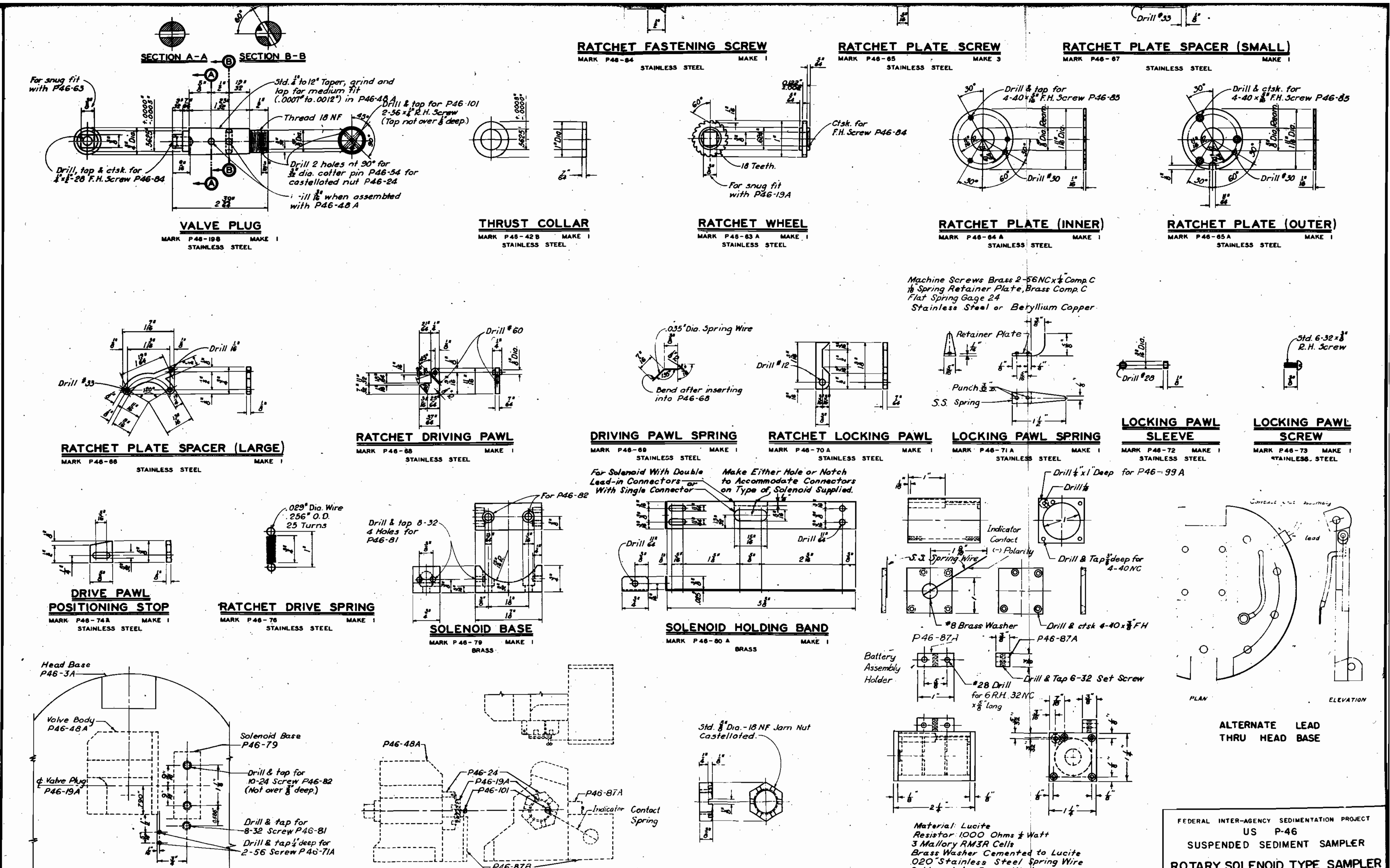
FEDERAL INTER-AGENCY SEDIMENTATION PROJECT

US P-46

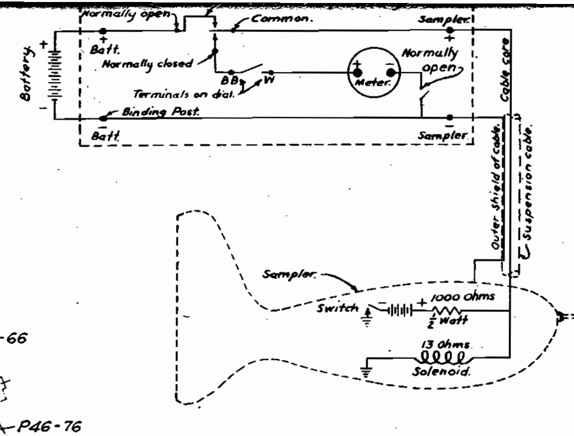
SUSPENDED SEDIMENT SAMPLER

ROTARY SOLENOID TYPE SAMPLER

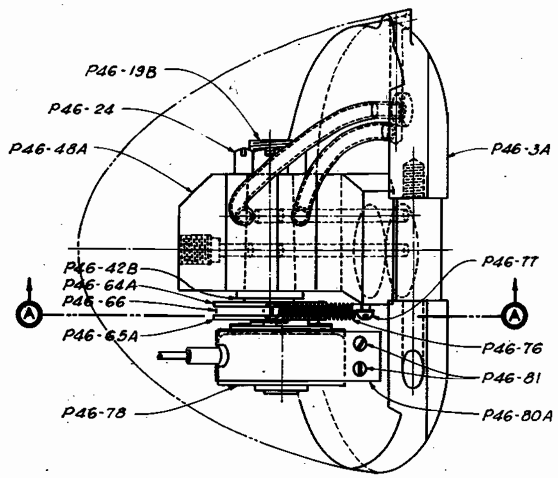
PARTS LIST



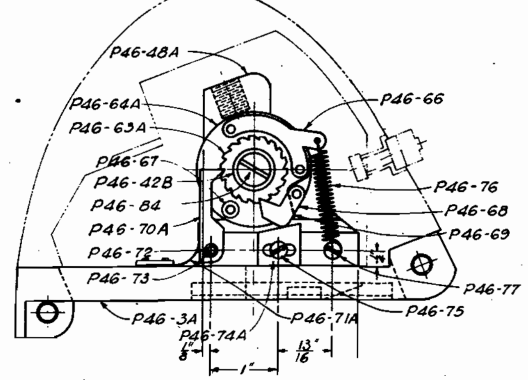
SECTION A-A
SECTION B-B
For snug fit with P46-63
Std. 1/8" to 12" Taper, grind and lap for medium fit (.0007" to .0012") in P46-48 A
Drill & tap for P46-101 2-56 x 1/4" R.H. Screw (Tap not over 1/8" deep.)
Thread 18 NF
Drill, tap & ctsk. for 1/4" x 1/2"-28 F.H. Screw P46-84
Drill 2 holes at 90° for 3/32" dia. cotter pin P46-54 for castellated nut P46-24
Drill 1/16" when assembled with P46-48 A
VALVE PLUG
MARK P46-19B MAKE 1
STAINLESS STEEL
THRUST COLLAR
MARK P46-42 B MAKE 1
STAINLESS STEEL
RATCHET FASTENING SCREW
MARK P46-84 MAKE 1
STAINLESS STEEL
RATCHET PLATE SCREW
MARK P46-85 MAKE 3
STAINLESS STEEL
RATCHET PLATE SPACER (SMALL)
MARK P46-67 MAKE 1
STAINLESS STEEL
Ctsk. for F.H. Screw P46-84
18 Teeth.
For snug fit with P46-19A
RATCHET WHEEL
MARK P46-63 A MAKE 1
STAINLESS STEEL
Drill & tap for 4-40 x 3/16" F.H. Screw P46-85
Drill #30
RATCHET PLATE (INNER)
MARK P46-64 A MAKE 1
STAINLESS STEEL
Drill & ctsk. for 4-40 x 3/16" F.H. Screw P46-85
RATCHET PLATE (OUTER)
MARK P46-65 A MAKE 1
STAINLESS STEEL
Machine Screws Brass 2-56NC x 1/4" Comp. C
1/16 Spring Retainer Plate, Brass Comp. C
Flat Spring Gage 24
Stainless Steel or Beryllium Copper
Drill #33
Drill 1/16"
RATCHET PLATE SPACER (LARGE)
MARK P46-66 MAKE 1
STAINLESS STEEL
Drill #60
RATCHET DRIVING PAWL
MARK P46-68 MAKE 1
STAINLESS STEEL
.035" Dia. Spring Wire
Bend after inserting into P46-68
DRIVING PAWL SPRING
MARK P46-69 MAKE 1
STAINLESS STEEL
Drill #12
RATCHET LOCKING PAWL
MARK P46-70 A MAKE 1
STAINLESS STEEL
Retainer Plate
Punch
S.S. Spring
LOCKING PAWL SPRING
MARK P46-71 A MAKE 1
STAINLESS STEEL
Drill #28
LOCKING PAWL SLEEVE
MARK P46-72 MAKE 1
STAINLESS STEEL
Std. 6-32 x 3/8" R.H. Screw
LOCKING PAWL SCREW
MARK P46-73 MAKE 1
STAINLESS STEEL
DRIVE PAWL POSITIONING STOP
MARK P46-74A MAKE 1
STAINLESS STEEL
.029" Dia. Wire
.256" O.D.
25 Turns
RATCHET DRIVE SPRING
MARK P46-76 MAKE 1
STAINLESS STEEL
Drill & tap 8-32 4 Holes for P46-81
For P46-82
SOLENOID BASE
MARK P46-79 MAKE 1
BRASS
For Solenoid With Double Lead-in Connectors or With Single Connector
Make Either Hole or Notch to Accommodate Connectors on Type of Solenoid Supplied.
Drill 11/64"
SOLENOID HOLDING BAND
MARK P46-80 A MAKE 1
BRASS
Drill 1/4" x 1" Deep for P46-99 A
Drill 1/8"
Indicator Contact
(−) Polarity
S.S. Spring Wire
Drill & Tap 3/8" deep for 4-40 NC
#8 Brass Washer
Drill & ctsk 4-40 x 3/8" F.H.
P46-87A
Battery Assembly Holder
#28 Drill for 6 R.H. 32 NC x 5/8" long
Drill & Tap 6-32 Set Screw
Material: Lucite
Resistor 1000 Ohms 1/2 Watt
3 Mallory RM3R Cells
Brass Washer Cemented to Lucite
.020" Stainless Steel Spring Wire
lead
PLAN
ELEVATION
ALTERNATE LEAD THRU HEAD BASE
Head Base P46-3A
Valve Body P46-48A
Valve Plug P46-19A
Solenoid Base P46-79
Drill & tap for 10-24 Screw P46-82 (Not over 3/8" deep.)
Drill & tap for 8-32 Screw P46-81
Drill & tap 1/4" deep for 2-56 Screw P46-71A
P46-48A
P46-24
P46-19A
P46-101
P46-87A
Indicator Contact Spring
P46-87B
Std. 5/8" Dia.-18 NF Jam Nut Castellated.
FEDERAL INTER-AGENCY SEDIMENTATION PROJECT
US P-46
SUSPENDED SEDIMENT SAMPLER
ROTARY SOLENOID TYPE SAMPLER



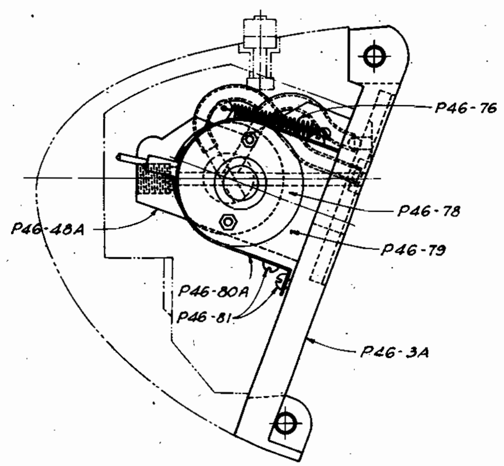
WIRING DIAGRAM



PLAN

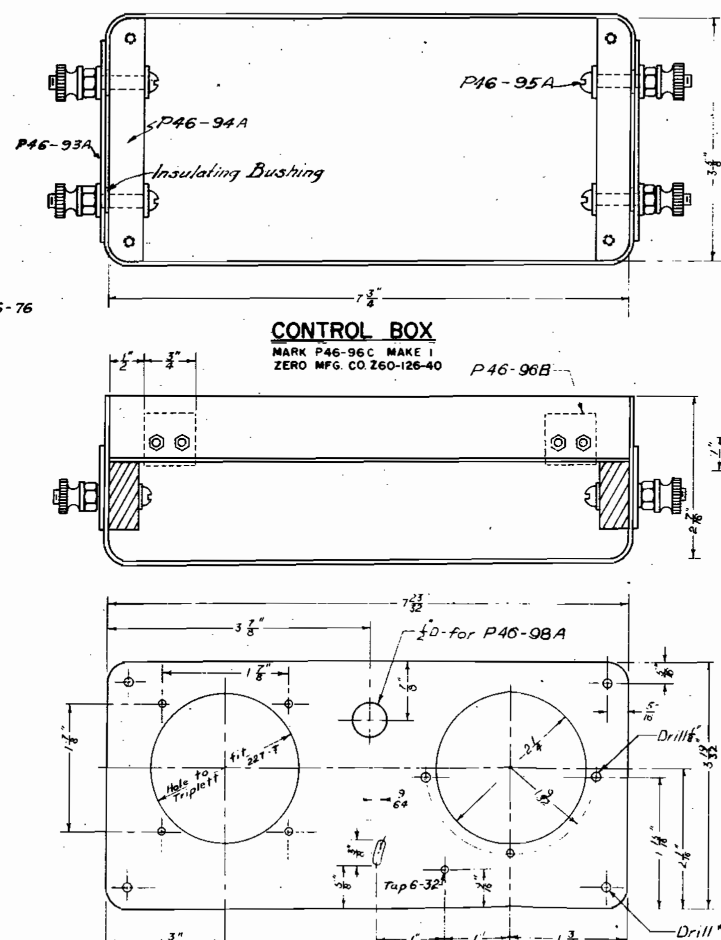


SECTION A-A



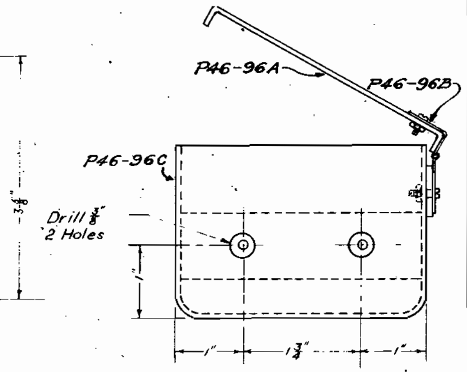
ELEVATION

VALVE MECHANISM



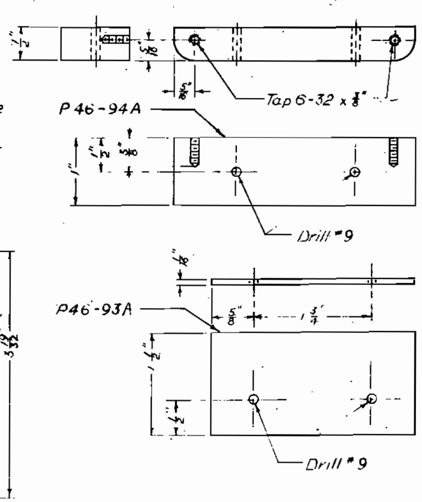
CONTROL BOX

MARK P46-96C MAKE 1
ZERO MFG. CO. Z60-126-40



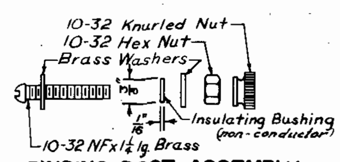
CONTROL BOX COVER

MARK P46-96A MAKE 1
ZERO MFG. CO. Z60-126-5



INSULATING PARTS

MARK P46-93 A MAKE 2



BINDING POST ASSEMBLY

MARK P46-95 A MAKE 4

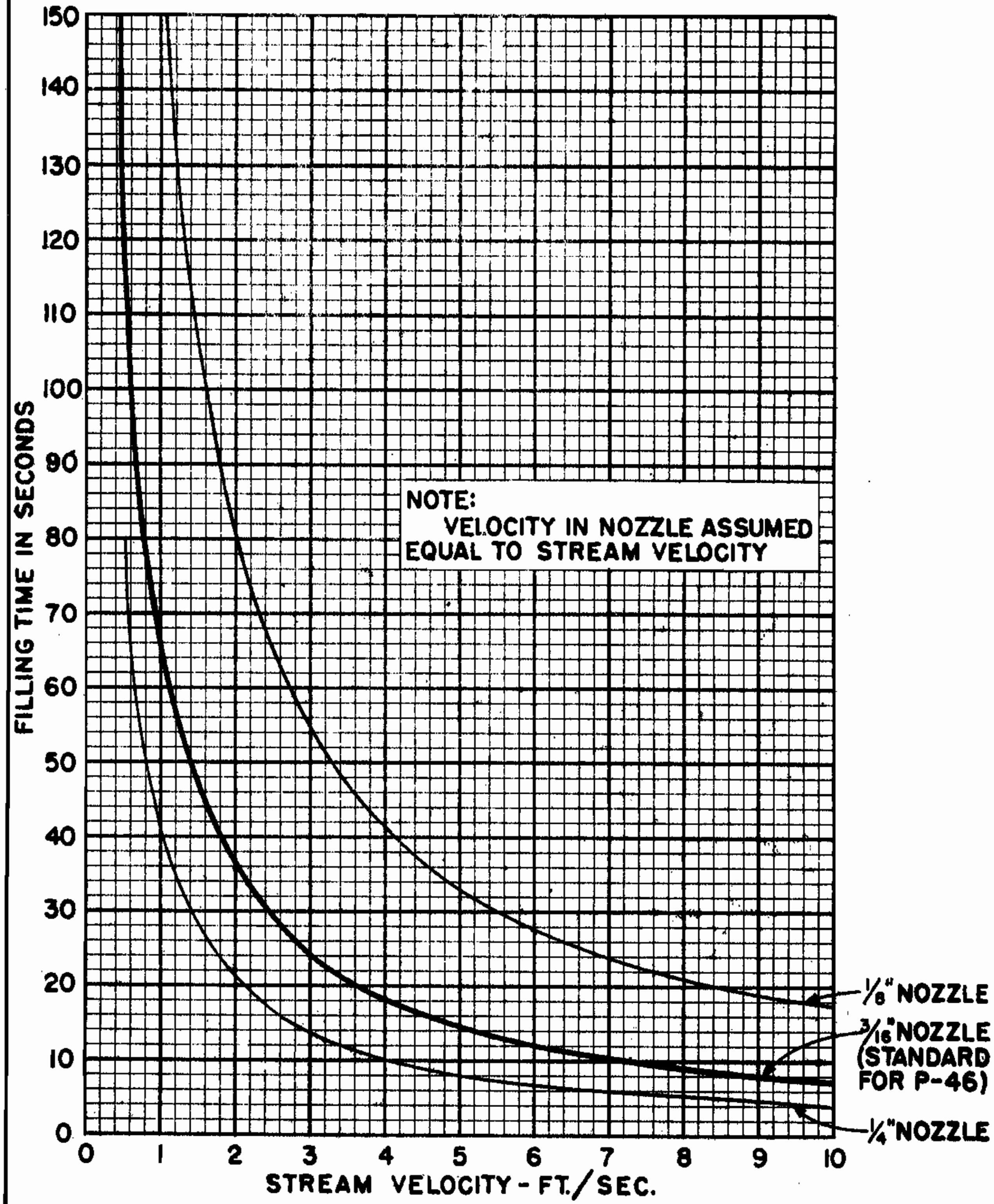
P46-1	Body	G.M. Bronze - 6	1	
P46-2	Head Cover	" " "	1	
P46-3A	Head Base	" " "	1	
P46-4	Container Shell	Brass - C	1	
P46-5	Spring	Stainless Steel	1	Or Beryllium Copper - Spring Temper
P46-6	Spring Holder	Brass - C	1	No. 16 B&S Gauge
P46-7	Screw - #10 R.H.-32 NF x ⅜" lg.	" - B	1	
P46-8	Catch	G.M. Bronze - 6	1	
P46-9	Catch Pin	Stainless Steel - 5	1	
P46-10	Catch Spring	Stainless Steel	1	Or Beryllium Copper - Spring Temper
P46-11	Intake Nozzle	Brass - B	1	
P46-12	Intake Nozzle Nut	" "	1	
P46-13	Gasket	Synthetic Rubber	1	"Linear" Hydraulic O-Ring or equal
P46-14	Hinge	G.M. Bronze - 6	1	
P46-15	Hinge Pin	Stainless Steel - 5	1	For P46-1
P46-15A	Hinge Pin	" " "	1	For P46-3
P46-16	Counterbalance	Brass - C	1	
P46-17	Counterbalance	" "	1	
P46-18	Counterbalance Screw	" - B	1	#12 F.H.-28 NF x 15/16" lg.
P46-19B	Valve Plug	Stainless Steel - 5	1	
P46-24	Valve Plug Nut	Brass	1	Or Stainless Steel Shear Nut.
P46-28	Sealing Gasket	Gum Rubber - Soft	1	3" O.D. - 1⅛" I.D. x 3/16" thick.
P46-33	Contact Post Assembly	Brass - Plastic - Rubber	1	
P46-34	Screw - ¼" Fillister H.-28 NF x 9/16" lg.	Brass - B	9	Or Stainless Steel Socket Head Cap Screw With Key
P46-37	Gasket - between P46-3 & 48	Rubber - Sheet	1	1/32" Thick
P46-38	Plug	Brass - C	1	
P46-39	Gasket	Rubber - Soft - A	1	
P46-40	Tubing - ¼" O.D. x 3/16" I.D. x 9" lg.	Copper - Type N	1	
P46-42B	Thrust Collar	Stainless Steel - 5	1	
P46-44	Screw - #12 F.H.-28 NF x ⅝" lg.	Brass - C	4	
P46-45	Gasket - between P46-2 & 3	Rubber - Sheet	1	1/32" Thick - see sheet 4
P46-48A	Valve Body	G.M. Bronze - 6	1	
P46-54	Cotter Pin - 3/32" Dia. x 1⅜" lg.	Brass	1	For P46-24
P46-63A	Ratchet Wheel	Stainless Steel - 5	1	
P46-64A	Ratchet Plate (inner)	Stainless Steel	1	
P46-65A	Ratchet Plate (outer)	" "	1	
P46-66	Ratchet Plate Spacer (large)	" "	1	
P46-67	Ratchet Plate Spacer (small)	" "	1	
P46-68	Ratchet Driving Pawl	Stainless Steel - 5	1	
P46-69	Driving Pawl Spring	Stainless Steel	1	
P46-70A	Ratchet Locking Pawl	Stainless Steel - 5	1	
P46-71 A	Locking Pawl Spring Assembly	See Detail	1	
P46-72	Locking Pawl Sleeve	Stainless Steel	1	Or Brass
P46-73	Locking Pawl Screw	" "	1	Or Brass #6 R.H.-32 x ⅜ lg.
P46-74 A	Drive Pawl Positiong Stop	Stainless Steel - 5	1	
P46-75	Pawl Positioning Stop Screw	Brass	1	#6 R.H.-32 NF x ⅜ lg.
P46-76	Ratchet Drive Spring	Stainless Steel	1	Or Beryllium Copper - Spring Temper (Gardner EBC) or Equal
P46-77	Drive Spring Screw	Brass	1	#6 RH-32 NF x ⅜ lg.
P46-78	Rotary Solenoid		1	LEDEX BD 53R 3527x5:9 By G.H. LELAND INC. Or Equal
P46-79	Solenoid Base	Brass, Comp. C	1	
P46-80A	Solenoid Holding Band	" "	1	
P46-81	Solenoid Band Screw	" "	5	#8 RH-32 NF x ¼ lg.
P46-82	Solenoid Base Screw	" "	2	#10 Fil.H.-32 NF x ¼ lg
P46-84	Ratchet Fastening Screw	Stainless Steel	1	Or Brass ¼" F.H.-28 x ½" lg.
P46-85	Ratchet Plate Screw	" "	3	Or Brass #4 F.H.-40 NF x 9/16 lg.
P46-87B	Indicator Battery Assembly	See Detail	1	
P46-87A	Battery Assembly Holder	Brass	1	
P46-88A	Micro Switch Mounting Nut	"	1	Hex Nut for 6-32 Machine Screw
P46-89A	Micro Switch Mounting Screws	"	2	#6 RH-32 NF x 1" lg.
P46-90	Dial		1	W.E.CO. Type 5HA3 Or Equal
P46-91A	Meter: 0-1 MA-DC		1	
P46-92	Micro Switch		1	Type B2-2RLT Or Equal
P46-93A	Binding Post Plates	Lucite	2	
P46-94A	Panel Block	"	2	
P46-95A	Binding Post Assembly	See Detail	4	
P46-96C	Control Box	Aluminum	1	ZERO MFG. CO Or Equal Z60-126-40
P46-96A	Control Box Cover	"	1	ZERO MFG. CO Z60-126-5 Or Equal
P46-96B	Hinge Assembly	See Detail: Brass	1	
P46-97A	Dial & Meter Panel	1/16" Aluminum	1	
P46-98A	Meter Switch		1	Hart & Hegeman Type 3391 Or Equal
P46-99A	Resistor 1000 Ohm ½ Watt		1	
P46-101	Contact Screw	Brass	1	#2 RH-56 NF x ¼ lg.

FEDERAL INTER-AGENCY SEDIMENTATION PROJECT

US P-46

SUSPENDED SEDIMENT SAMPLER

ROTARY SOLENOID TYPE SAMPLER



FILLING TIME FOR SAMPLE OF 400 c.c.

FIG. 9.