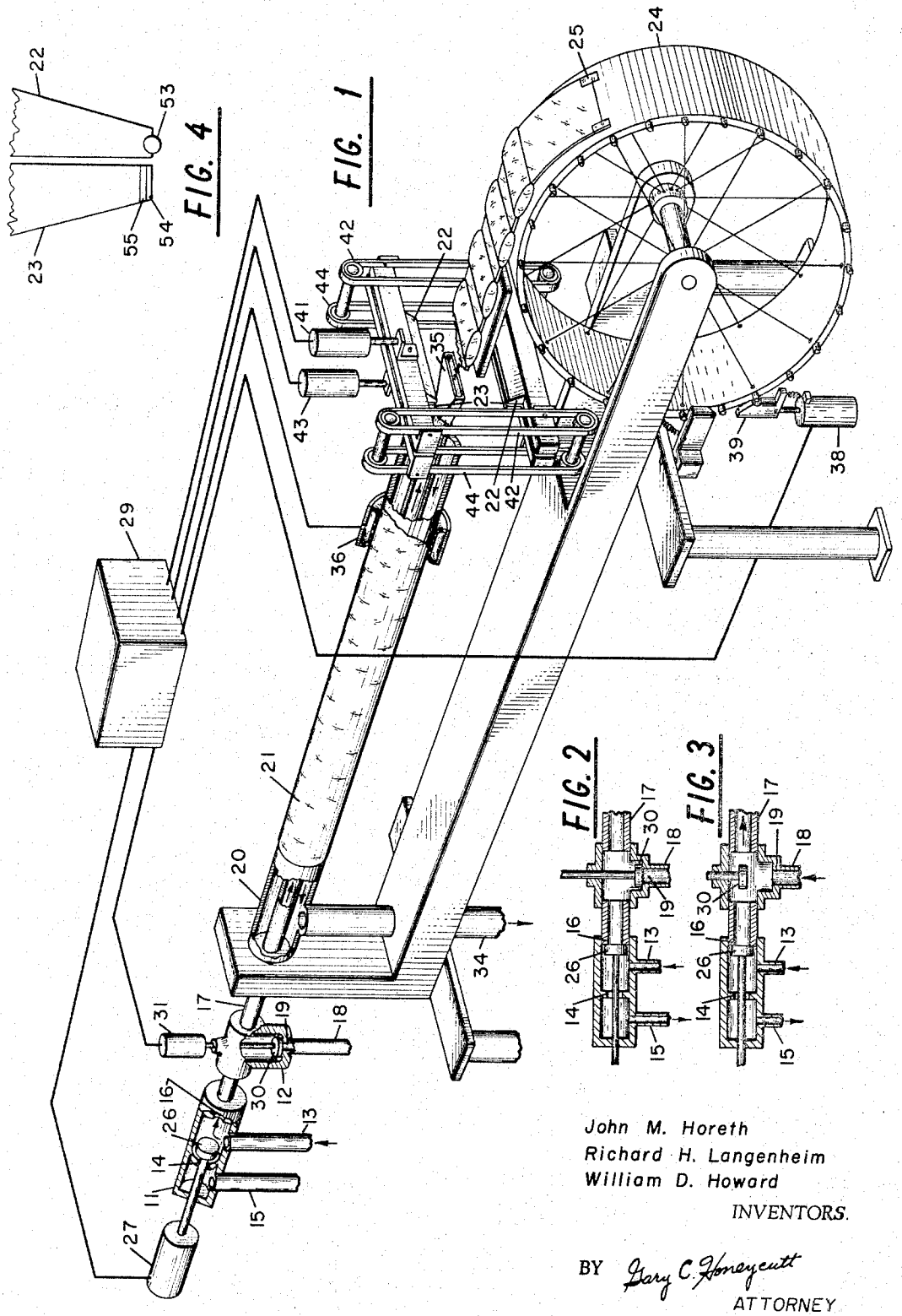
Aug. 1, 1967 J. M. HORETH ETAL 3,333,391

AUTOMATIC MUD SAMPLER AND PACKAGER

Filed April 21, 1964 2 Sheets-Sheet 1



John M. Horeth
Richard H. Langenheim
William D. Howard
INVENTORS.

BY Gary C. Honeycutt
ATTORNEY

Aug. 1, 1967 J. M. HORETH ETAL 3,333,391

AUTOMATIC MUD SAMPLER AND PACKAGER

Filed April 21, 1964 2 Sheets-Sheet 2

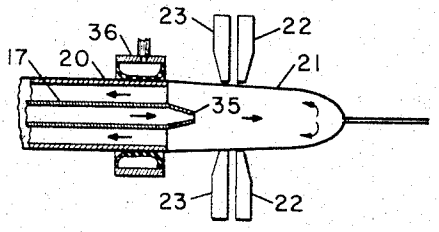


FIG. 5

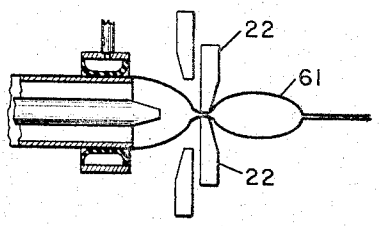


FIG. 6

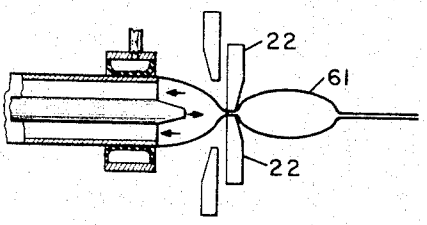


FIG. 7

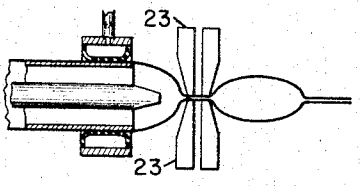


FIG. 8

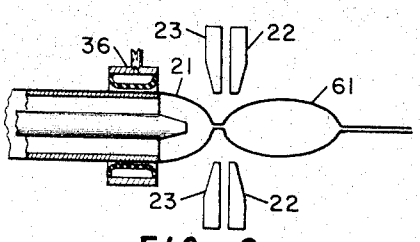


FIG. 9

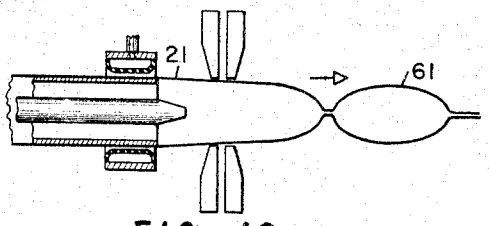


FIG. 10

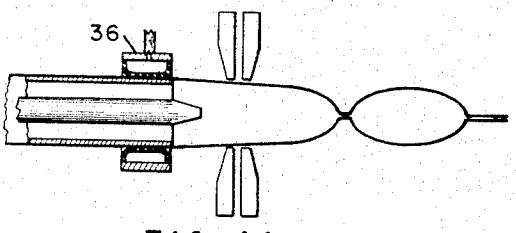


FIG. 11

John M. Horeth
Richard H. Langenheim
William D. Howard
INVENTORS.

BY Gary C. Honeycutt
ATTORNEY

United States Patent Office 3,333,391 Patented Aug. 1, 1967

3,333,391

AUTOMATIC MUD SAMPLER AND PACKAGER

John M. Horeth, Richard H. Langenheim, and William D. Howard, Tulsa, Okla., assignors, by mesne assignments, to Esso Production Research Company, Houston, Tex., a corporation of Delaware

Filed Apr. 21, 1964, Ser. No. 361,513
9 Claims. (Cl. 53—28)

This invention relates to the packaging of fluid mixtures which contain large amounts of suspended or entrained particulate solids. In a particular aspect, the invention relates to apparatus for the packaging of drilling fluid samples obtained in the rotary drilling of boreholes in the earth, especially in the drilling of oil and gas wells. In a preferred embodiment, a package is produced which preserves the original gas content of the sample for quantitative analysis.

The incentives for analyzing periodic samples of drilling mud for the presence of hydrocarbon gases have been recognized for many years. Such analysis of the drilling mud, when correlated with the drilling depth, gives a more immediate and reliable indication of the presence of valuable petroleum deposits than any other method of well logging. However, extensive routine use of quanitative hydrocarbon mud-gas logging has been slow to develop, due in part to the difficulty of obtaining reliable, representative samples of the mud stream. Moreover, once representative samples are obtained, it is difficult to preserve the mud samples in such a way as to prevent the escape of hydrocarbon gases.

In a great many drilling operations it is conventional practice to collect mud samples manually. That is, from time to time field personnel at the drilling site simply scoop a bucket of fluids from the mud riser box, or from some other exposed mud surface, and label the sample to indicate drilling depth or time, or both. This method of sample collection is unsatisfactory for several reasons. Perhaps most important is the fact that the mud has been exposed to the atmosphere prior to collection, thus enabling a major proportion of the light gases, especially methane and ethane, to escape if they were initially present. Moreover, human fallibility introduces various errors, both in the composition of samples and in the correlation of sampling time with drilling depth.

Accordingly, it is an object of the present invention to provide an apparatus for obtaining uniform, representative samples of drilling mud from the return flowline at accurately timed intervals. It is a further object to package the samples in a manner which will preserve their original composition, especially with respect to hydrocarbon gas content.

The apparatus of the present invention receives a continuous sample stream of drilling mud from the return flowline, or from the surface conductor casing, for the purpose of packaging periodic samples for analysis. While the apparatus is on standby basis, the sample stream is simply diverted to the mud pits. At timed intervals the sample stream is passed through a delivery tube which directs the mud to a sealing system where a sample of the mud is encased in a plastic pouch. The operation is repeated at selected intervals until a large number of samples are collected in a fixed sequence and correlated with drilling depth.

The sampling and packaging device of the present invention is composed of four principal sub-systems or sub-combinations. Following the sequence in which the systems operate, the first is a flow control system, or valve assembly, which is itself sub-divided into two parts. A first valve places the mud sample stream alternately on standby basis, and then switches to a sampling cycle at periodic intervals.

A second valve functions to supply a stream of water of periodic intervals, timed to coincide with the standby position of the mud control valve.

The second major sub-combination includes a conduit for periodic delivery of the sample stream to the packaging system, and means for disposal of excess mud supplied to the packaging system. In a preferred embodiment, the mud disposal means also provides temporary storage for the flexible packaging material in which the mud samples are to be encased or sealed.

The sealing means, located near the outlet end of the delivery tube, consists essentially of a pair of clamping jaws and a pair of heat seal jaws. The packaging material is fed from temporary storage through the space between the two pairs of jaws. A continuous flow of the sample stream passes from the delivery tube into that portion of the packaging film located between the jaws, and thence through the mud disposal line. At a time designated for the sealing of each successive sample, the clamping jaws are activated first, whereby a pouch of mud is held separate from the flowing stream. At this time the flow of mud is interrupted and a stream of water is passed through the delivery tube and disposal line in the same manner as was the mud. During the flow of water, the clamping jaws remain firmly engaged against opposite sides of the plastic tube, to prevent passage of fluids between the jaws. Once the flow of water has cleaned the inner surface of the plastic tube immediately adjacent the area held by the clamping jaws, the heat seal jaws are activated, while the clamping jaws remain firmly engaged. The flow of water is then interrupted and electric current is passed through the heating element of the sealing jaws to complete the formation of a gas-tight seal, thereby preserving the true composition of the packaged sample.

Both the clamping jaws and the sealing jaws are then retracted to permit the advance of the sample storage wheel, in order to place a fresh portion of the packaging material in position for the formation of the next successive sample pouch.

FIGURE 1 is an isometric view of an embodiment of the packaging apparatus of the invention.

FIGURES 2 and 3 are cross-sectional views of the flow control system of the apparatus of FIGURE 1.

FIGURE 4 is a cross-sectional view of the upper blades of the clamping and heat seal jaws of the apparatus of FIGURE 1.

FIGURE 5 through 11 are diagrammatic sectional views of the clamping and sealing jaws, illustrating the sequence of steps involved in the operation of the apparatus.

Referring to FIGURE 1, the apparatus is seen to consist of four major sections: a flow control system, a delivery section, a packaging section, and a collection and storage assembly. The flow control system includes valves **11** and **12**, the first of which functions to direct a sample stream of mud from line **13** through port **14** and discharge line **15**, and alternately through port **16** into delivery tube **17**. Valve **12** functions to direct a stream of water through line **18**, port **19** and delivery tube **17** for the purpose of periodically flushing the system, as more fully explained in connection with the packaging section as discussed below.

The elongated central area of the illustrated embodiment includes delivery tube **17** and outer flow tube **20**, substantially concentric therewith. Tubular film **21**, stored along the outer surface of tube **20**, is composed of a highly flexible, heat-sealable, gas-retentive membrane having a relatively high tensile strength.

The packaging section is composed of clamping jaws **22** and heat seal jaws **23** which function, respectively, to form each successive pouch and hold it separate from a flowing stream of water which removes excess mud and

particulate solids from the area to be sealed; and then to form a permanent heat seal, thus completing the formation of each successive pouch.

The collection and storage section consists essentially of a large diameter wheel **24** to which one end of tubular film **21** is fastened at point **25**. Periodic rotation of the wheel, in a clockwise direction from the side viewed, through an arc corresponding to the space occupied by a single pouch at the perimeter of the wheel, advances each successive segment of the packaging film from its position on tube **20** to a location between jaws **22** and **23**, in readiness for the formation of the next successive sample pouch.

In valve **11**, the position of plunger **26** is controlled by double-acting pneumatic piston **27**. For example, in the position shown, plunger **26** is seated against port **14** thereby forcing the flow of mud through port **16** into delivery tube **17**. In the alternate position, plunger **26** seats against port **16** thereby directing the flow of mud through port **14** and discharge line **15**. The flow of air to pneumatic piston **27** is controlled by a solenoid-actuated valve, which in turn is actuated by time sequence controller **29**.

In valve **12**, the position of plunger **30** is controlled by double-acting pneumatic piston **31**. For example, in the position shown, plunger **30** is seated against port **19** thereby excluding the flow of water and permitting the passage of mud through port **16** into delivery tube **17**. In the opposite position, plunger **30** is lifted at a time when plunger **26** is seated against port **16**, thereby permitting the influx of water to delivery tube **17** while mud flow is excluded. The flow of air to pneumatic piston **31** is also controlled by a solenoid-actuated valve, which in turn is activated by a signal from time sequence controller **29**.

The specific description of valves **11** and **12**, including the description of the actuation means associated therewith, is for the purpose of illustration only. It is within the scope of the invention, in its broadest form to substitute other flow control means for producing an equivalent manipulation of stream flow.

The end of delivery tube **17** is flared outward to form an elongated rectangular outlet **35**. The primary function of the flared portion is to shape the packaging material just prior to the clamping and sealing stage of the operation, in order to prevent the formation of wrinkles between the clamping and sealing jaws, thus providing a smooth seal. Moreover, the flared outlet improves the cleaning efficiency of the flushing operation just prior to the sealing step, ensuring a clean inner packaging surface between the heat-seal jaws. An additional shaping action may readily be obtained, if desired, by equipping the flared outlet with a longitudinal rib or finlike extension along the outer surface of the major transverse axis. Such an extension also aids the flow of mud into discharge line **20**.

The upper blade of clamping jaws **22** is driven by double-acting pneumatic piston **41**. The lower blade is simultaneously driven upward by the same force, transmitted through endless chain pair **42**. Similarly, the upper half of heat seal jaws **23** is driven by piston **43**, and the lower half is forced upward by endless chain pair **44**.

Wheel **24** is periodically advanced by ratchet and pawl mechanism **39**, actuated by piston **38**, which is in turn operated by a solenoid valve, and controller **29**.

In FIGURE 4 the detailed construction of the upper blades of jaws **22** and **23** is shown. The gripping edge of blade **22** is provided with an elastomeric pad **53** bonded within a groove or depression along the metallic blade. Electrical heating element **54** consists essentially of nichrome ribbon, and is separated from blade **23** by means of insulating layer **55**. The lower blades of jaws **22** and **23** are mirror-image duplicates of the upper blades.

As a specific example of the operation of the device, a continuous stream of mud is supplied through line **13** at the rate of 3 gallons per minute. Referring to FIGURE 1, the initial stage of the operation is begun with the illustrated positions of plungers **26** and **30** of valves **11** and **12**, respectively. The mud stream is thereby directed through tube **17** into the packaging area, where it emerges from rectangular outlet **35**. The direction of mud flow is reversed by the packaging film and is then discharged along the annulus between lines **17** and **20**, and through dump line **34**. The clamping and sealing jaws are open, as shown in FIGURE 5. During this period of circulation the tubular packaging material is held stationary by expandable pneumatic clamp **36**, which also serves to prevent the leakage of mud through the narrow annular space surrounding the outer surface of tube **20**. The leakage of mud through this annular space would represent no serious loss in terms of mud volume; however, due to its abrasive nature and the presence of some large cuttings, the leakage of mud into this annular space is considered very undesirable inasmuch as it may lead to the development of leaks in the packaging material through a cutting or tearing action during its periodic advance along the surface of tube **20**.

The preferred example of flexible tubular packaging material consists essentially of inner and outer laminations of plastic resin film. The outer lamination is polyethylene terephthalate resin film, known by the trademark "Mylar," having a thickness of .0005 inch. The inner lamination is polyethylene resin film having a thickness of .002 inch. It is a preferred feature of this particular film, as well as of any suitable equivalents, that the material must possess a high degree of hydrocarbon gas retentiveness. In the preferred example, such rententiveness is characteristic of the Mylar lamination.

The packaging material must also be readily amenable to the formation of a permanent, gas-tight heat seal. In the preferred embodiment this characteristic is supplied by the polyethylene lamination. Studies have shown that the inner lamination of polyethylene should not exceed .002 inch in thickness because of its propensity to absorb significant quantities of hydrocarbon gas from the mud sample.

Other flexible, heat-sealable packaging materials may be used, including metal foils, for example. A foil may be used alone, or as a lamination with a synthetic resin film. Pressure alone is capable of forming a metal-to-metal seal, without the need for heat.

With a continued flow of mud stream through the confined space near outlet **35**, the clamping jaws **22** are activated and engaged against opposite sides of tube **21** to form a mud sample pouch **61** as illustrated in FIGURE 6. With clamping jaws **22** remaining engaged, a signal is received from controller **29** by the solenoid which activates pneumatic piston **31** and lifts plunger **30**, thereby admitting a stream of water through line **18** and port **19**. This position of plungers **26** and **30** is illustrated in FIGURE 3, and the position of the clamping and sealing jaws is shown in FIGURE 7. The circulation of water within the space confined by packaging film **21** at the end of delivery tube **17** functions primarily to remove mud and cuttings from the inner surface of film **21** lying opposite sealing jaws **23**. About 15 seconds of water flow is usually adequate to clean the sealing area, whereupon the heat seal jaws are activated to the position indicated in FIGURE 8, immediately adjacent the area held by clamping jaws **22**. The flow of water is then interrupted by a signal from controller **29** which returns plunger **30** to its seated position, closing port **19**.

The position of plungers **26** and **30** at this time is illustrated in FIGURE 2. Electric current is then supplied to heating element **53** of sealing jaws **23**, thereby completing the formation of a sealed mud pouch. Upon completion of a seal, both clamping jaws **22** and heat

seal jaws **23** are returned to their retracted positions as indicated in FIGURES 1 and 9.

At this time signals are received from controller **29** by clamp **36** and ratchet actuator **38**. The consequent release of clamp **36** and rotation of wheel **24** causes the packaging film to be advanced to a new position, as illustrated by FIGURE 10. Clamp **36** is then actuated, as shown in FIGURE 11, and a new cycle is begun.

The entire operation of sampling, packaging and storing requires about one minute. The operation is controlled by sequence controller **29** which is operated by a 60 cycle 110 volt A.C. synchronous motor geared down to 1 r.p.m. The controller allows the mud to be sampled after each 5, 10, 15 or 30 minute interval. The sampling frequency should be selected in accordance with the drilling rate, to obtain mud samples which represent a constant drilling depth interval. Also the controller contains, or is connected with, a conventional Geolograph chart recorder, or other drilling time recorder, in order to prepare a record of the time at which each particular sample is packaged. Thus by comparing the packaging sequence controller record with the drilling time record, the drilling depth for each mud sample is readily identified. As understood by one skilled in the art, the sampling time may be correlated with drilling depth by calculating the lag time required for a given increment of mud to rise from bottom hole to the mud return flow line, or to the surface conductor casing.

What is claimed is:

1. Apparatus for packaging samples of a solids-laden fluid which comprises

a delivery tube;

means for periodically advancing a flexible, heat-sealable, tubular film along the outside of said delivery tube and past the outlet end thereof;

means for flowing a stream of said fluid through said delivery tube and into contact with the interior of said film, whereby said fluid is then discharged through an annular path between said tube and said film,

means for releasably clamping said flexible material to separate a sample of the fluid from said stream;

means for interrupting the flow of said stream;

means for flowing a stream of substantially solids-free fluid through said delivery tube and into contact with the interior of said film to flush said solids-laden fluid from that portion of the film to be heat-sealed; and

means adjacent said clamping means for applying pressure and heat to said heat-sealable material, thereby sealing said sample.

2. Apparatus for packaging samples of a solids-laden fluid which comprises

a delivery tube;

a discharge tube positioned to enclose a flow path along the outside of said delivery tube;

means for periodically advancing a flexible, heat-sealable, tubular packaging material along the outside of said discharge tube and past the outlet end of said delivery tube;

means for flowing a stream of said fluid through said delivery tube and into contact with the interior of said packaging material, whereby said fluid is then directed along said discharge flow path;

means for releasably clamping said packaging material to separate a sample of the fluid from said stream;

means for interrupting the flow of said stream;

means for flowing a stream of substantially solids-free fluid through said delivery tube and into contact with the interior of said packaging material to remove said solids-laden fluid from that portion of the interior of said packaging material to be heat-sealed; and

means adjacent said clamping means for applying pressure and heat to said packaging material, thereby sealing said sample.

3. Apparatus as defined by claim **2**, wherein the outlet end of said delivery tube is transversely elongated, and the major axis thereof is substantially parallel to the contact surfaces of said clamping and sealing jaws when closed.

4. Apparatus as defined by claim **2**, including means for releasably clamping the packaging material to the perimeter of said discharge tube.

5. In a device for the packaging of samples of a solids-laden fluid comprising a delivery tube, means for periodically advancing a flexible, heat-sealable tubular film along the outside of said tube and past the outlet end thereof, means for flowing a stream of said fluid through said delivery tube into contact with the interior surface of said film, and means for heat-sealing successive intervals of said film, the improvement comprising a pair of clamping jaws in combination with means for flowing a stream of substantially solids-free fluid through said delivery tube to flush said solids-laden fluid from the interior of said film opposite said heat-sealing means, said jaws being located adjacent said heat-sealing means, and actuatable to form a temporary pressure seal in said film while the area to be heat-sealed is being flushed clean.

6. Apparatus for packaging samples of a particulate solids-containing fluid which comprises

a delivery tube;

means for periodically advancing a flexible packaging material along the outside of said delivery tube and past the outlet end thereof;

means for flowing a stream of said fluid through said delivery tube and into contact with the interior of said packaging material, whereby said fluid is then discharged along a path between said delivery tube and said packaging material;

means for releasably clamping said packaging material in order to separate a sample of said fluid from said stream;

means for interrupting the flow of said stream;

means for flushing the interior of that portion of said packaging material to be heat-sealed, to remove said fluid and particulate solids; and

means adjacent said clamping means for sealing said packaging material, thereby encasing a sample of said fluid.

7. In a device for the packaging of samples of a particulate solids-containing fluid comprising

a delivery tube,

means for periodically advancing a flexible tubular material along the outside of said tube and past the outlet end thereof,

means for flowing a stream of said fluid through said delivery tube into contact with the interior surface of said flexible material, and

means for permanently sealing successive intervals of said flexible material,

the improvement comprising a pair of clamping jaws in combination with means for flushing that portion of the interior of said flexible material to be heat-sealed,

said jaws being located adjacent said sealing means and actuatable to form a temporary pressure seal in said flexible material while the area to be permanently sealed is being flushed clean.

8. A method for packaging samples of a solids-laden fluid which comprises

flowing a stream of said fluid through a conduit;

advancing a flexible tubular packaging material along the outside of said conduit and past the outlet end thereof;

clamping said packaging material a short distance downstream from the outlet end of said conduit, whereby the direction of flow of said stream is reversed causing said stream to be discharged along a path between the outside of said conduit and the inside of said packaging material, and whereby a sample of

said fluid is held separate from said flowing stream;
thereafter interrupting the flow of said stream;
then flushing the interior of that portion of said packaging material to be heat-sealed; and
then forming a permanent seal in said packaging material to isolate said sample.

9. A method for packaging a series of samples of a solids-laden fluid which comprises
advancing a flexible tubular film along the outside of a delivery tube and past the outlet end of said tube;
then flowing a stream of said fluid through said delivery tube into contact with the interior surface of said film,
then forming a temporary seal across said film whereby said fluid is discharged through a path formed by said tube and said film,
interrupting said flow,

then flushing the interior of that portion of said film to be heat-sealed; and
thereafter forming a permanent seal adjacent said temporary seal to complete the formation of a sealed sample package.

References Cited

UNITED STATES PATENTS

2,145,941	2/1939	Maxfield	53—28 X
2,160,367	5/1939	Maxfield	53—28 X
2,928,216	3/1960	Orsini	53—22
3,020,689	2/1962	Luther	53—140
3,040,490	6/1962	Virta	53—28 X
3,164,934	1/1965	Pancratz	53—112

TRAVIS S. McGEHEE, *Primary Examiner.*

FRANK E. BAILEY, N. ABRAMS, *Assistant Examiners.*