Oct. 4, 1960 J. H. SEBALD 2,954,965

MULTI-UNIT SAMPLE COOLER

Filed Jan. 22, 1959 2 Sheets-Sheet 1

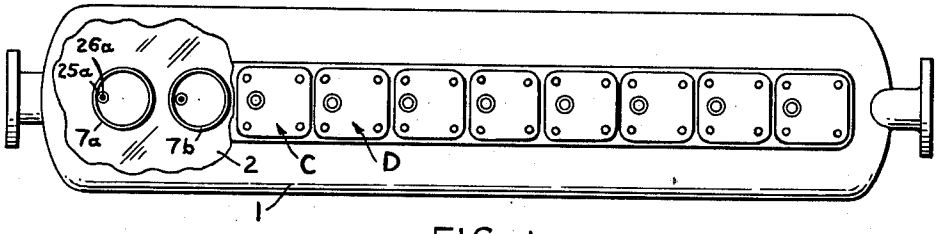


FIG. 1

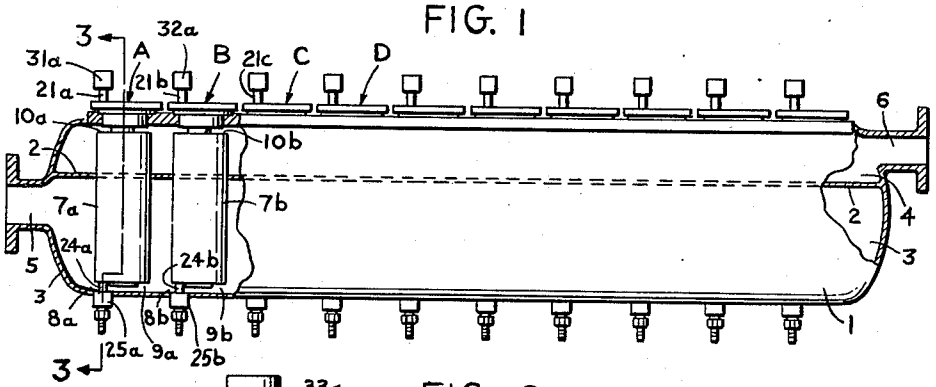


FIG. 2

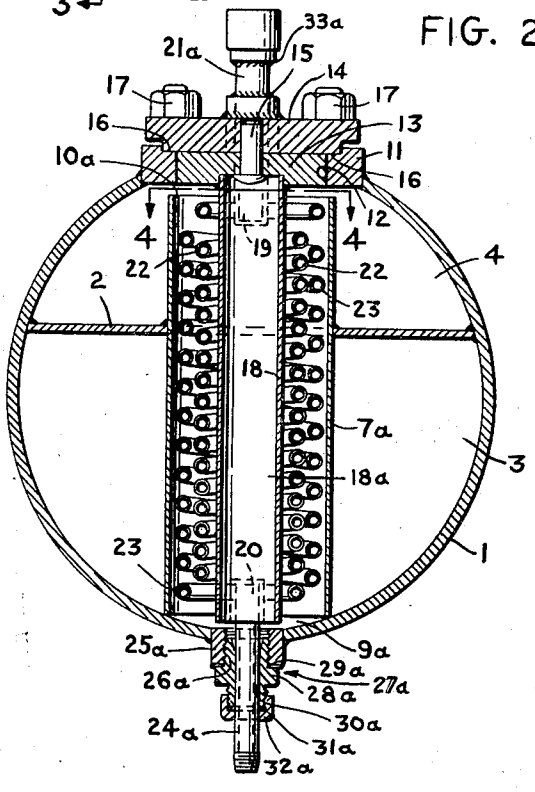


FIG. 3

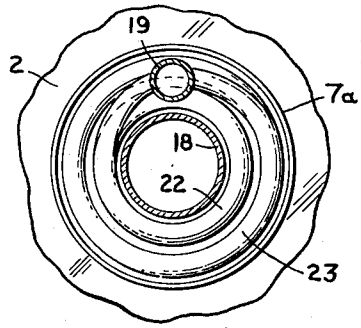


FIG. 4

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MULTI-UNIT SAMPLE COOLER

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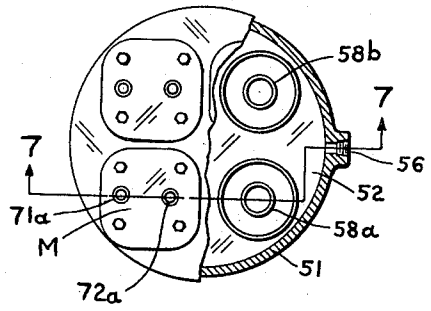


FIG. 5

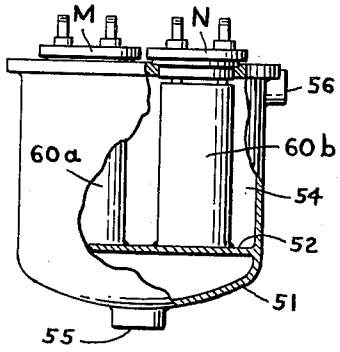


FIG. 6

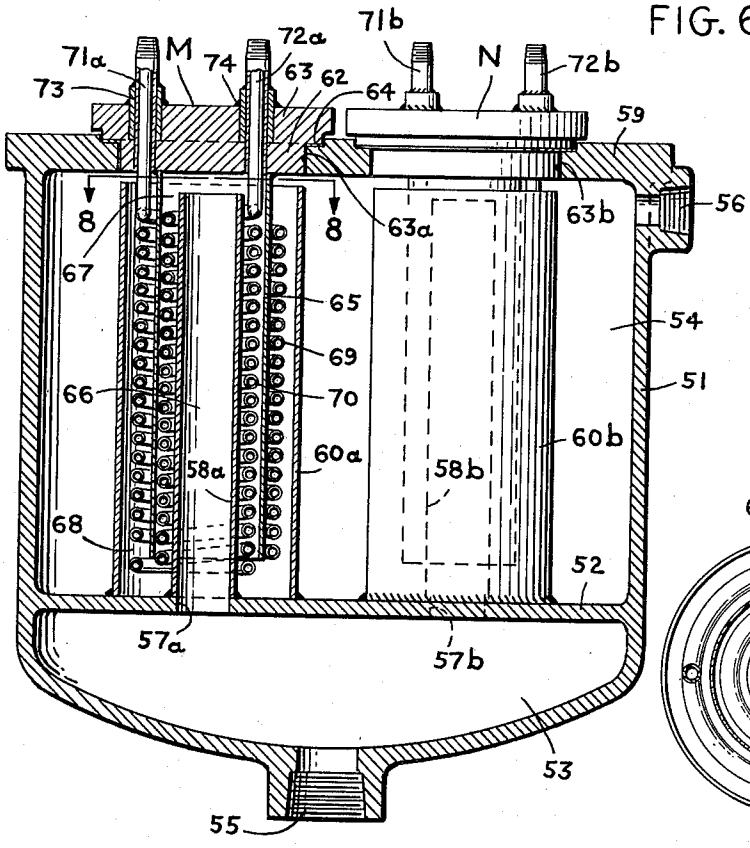


FIG. 7

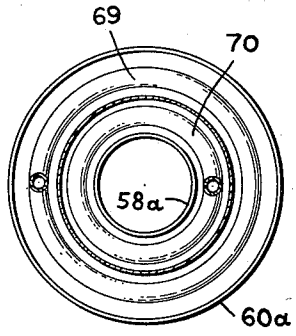


FIG. 8

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MULTI-UNIT SAMPLE COOLER

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9 Claims. (Cl. 257—235)

This invention relates generally to heat exchange apparatus and more particularly to a multi-unit cooler for cooling liquid samples or condensing water vapor for boiler feed systems or other process apparatus for the purpose of permitting a determination of the various inorganic and other components of the cooled liquid or condensed vapors as for example, oxygen content, carbonates, sulphates, etc.

It is known to utilize cooler units for taking a single sample from some point in a boiler feed system or other process.

Where it is necessary to take a plurality of different samples at different points in the system or from different systems the use of single unit coolers takes up a lot of space and requires a maze of intricate piping for the introduction and return of the cooling water.

The present invention overcomes this problem by providing a compact and simple sample cooler including a plurality of units wherein the sample cooling units are so disposed with respect to a common cooling system that the cooling water is adapted to flow through each of the sample cooling units at the desired predetermined flow rate for obtaining uniform samples of liquid or condensed vapor from the system.

Accordingly, it is an object of the present invention to provide a simple and compact multi-unit sample cooler for cooling a plurality of liquid samples or condensing water vapor samples from a boiler feed system or other process system using either liquid or steam.

Further objects and advantages of the invention will become evident from the following description with reference to the accompanying drawings in which:

Figure 1 is a plan view of a preferred form of the invention, broken away to show a top view of two sample cooler unit casings.

Figure 2 is a side view of the preferred form of the invention shown in Figure 1, partly in section showing side views of several of the sample cooler units in assembled position.

Figure 3 is a section taken on line 3—3 of Figure 2.

Figure 4 is a section taken on line 4—4 of Figure 3.

Figure 5 is a plan view of another form of the invention, broken away to show two sample cooler unit casings.

Figure 6 is a side view of the form of the invention shown in Figure 5 partly in section to show side views of sample cooler units in assembled position.

Figure 7 is a partial cross-section taken on line 7—7 of Figure 6.

Figure 8 is a cross-section taken on line 8—8 of Figure 7.

Referring to the drawings, Figures 1 to 4 show one form of the multi-unit sample cooler as having an elongated cylindrical housing or shell 1 with a longitudinally extending partition 2 to divide the shell into a lower chamber 3 and an upper chamber 4. The lower chamber 3 communicates with a continuously supplied source of cooling water (not shown) by means of a cooling water

inlet 5 and the upper chamber 4 communicates with a cooling water outlet 6.

Disposed transversely of the longitudinal line of the shell 1 and extending in fluid tight connection through the partition 2 in spaced relation to each other are a plurality of liquid or stream sample cooler units generally designated *a*, *b*, *c*, *d*, etc. in Figures 1 and 2.

Each of these units includes a hollow cylindrical sample cooler casing as at 7*a* and 7*b*, etc., which casings are open at their respective ends and of a length less than the inner diameter of the shell.

Since each of the sample cooler units is the same, only one is illustrated as shown in Figures 3 and 4 of the drawings. Thus, the casings as, for example, casing 7*a* in assembled position abuts that portion of the inner wall of the shell 1 which forms the lower chamber 3. Figure 3 further shows that the casing is square across the end. Since the shell 1 is circular in cross section, this permits the casing ends to be brought into abutment with the shell to form inlet ports as shown at 8*a* and 9*a*, and 8*b* and 9*b*, etc. in Figure 2.

These inlet ports 8*a* and 9*a* and 8*b* and 9*b*, etc. will be in communication with the lower chamber 3. Thus, when fluid fills the lower chamber it will have free access into the respective cylindrical casings 7*a*, 7*b*, etc. At the end remote from the inlet ports a full open outlet port as at 10*a* and 10*b* is formed for each of the cylindrical casings because they by reason of their length will be a spaced distance from that portion of the inner wall of the shell forming the upper chamber 4. Hence, fluid which enters the cylindrical casings 7*a*, 7*b*, etc. is discharged into the upper chamber 4 through these respective outlet ports and the differential area between the inlet ports and the outlet ports will permit the free flow of all fluids from the inlet 5 through lower chamber 3, cylindrical casings 7*a*, 7*b*, etc. and upper chamber 4 to the outlet 6.

If the inlet ports 8*a* and 9*a*, and 8*b* and 9*b*, etc. are properly sized, any desired rate of flow can be obtained within the limits of the diameter of the respective cylindrical casings and the remaining coil portions of the sample cooler units which fit therein.

It will be understood that while this type of inlet port is illustrated for this form of the invention that various other inlet ports can be devised by persons who are skilled in the art and understand their purpose without departing from the scope of the present invention.

Fitted into each of the cooler casings 7*a*, 7*b*, etc. are suitable coil means for passing the samples of liquid to be cooled or steam to be condensed therethrough.

Coil units

Thus Figures 2 and 3 show that in alignment with the longitudinal axis of each of the cylindrical casings as with cylindrical casing 7*a*, there is an annular sample cooler flange or rim 11 having an opening 12 which is slightly less in diameter than the inner diameter of the casing 7.

Substantially integral units are adapted to be fitted through the respective openings and to seat on the rim and such units include a carrier head 13 and a fastening head 14 which are fixedly connected to each other by any suitable means such as the rivet 15. The carrier head 13 fits in snug engagement with the opening 12 and forms a shoulder as at 16 with the fastener head 14, which shoulder will engage the outer face of the flange or rim 11. The heads 13 and 14 are connected to the rim by suitable means such as threaded members 17.

Fixedly connected to the carrier head 13 is a cylindrical partition or baffle 18 comprising an elongated pipe-like member disposed in assembled position in the center or axial line of its respective cylindrical casing and defining therewith an annular flow passage 18*a*.

Disposed in the respective upper and lower ends of each of the annular flow passages **18***a* are an upper T element **19** and a lower T element **20**, which by reason of their positions are offset from the center or axial line of the cylindrical casing. Thus, the respective sample cooler inlets **21***a*, **21***b*, **21***c*, etc. for each unit are also offset from the center line of its respective cylindrical casing and extends through the carrier head **13** and fastening head **14** to connect to the inlet T element **19** as is clearly shown in Figure 3 of the drawing.

The respective sample cooler inlets **21***a*, **21***b*, **21***c*, etc. serve to support the T elements and the coils connected thereto.

Thus, Figures 3 and 4 show connected to the respective inlet and outlet T elements **19** and **20**, inner coil **22** and an outer coil **23** which coils are spiral in shape and provide a convoluted flow path for the sample of liquid or steam delivered to the inlets **21***a*, **21***b*, etc. for the particular unit.

The T elements **19** and **20** and the coils **22** and **23** are disposed in assembled position to fit between the cylindrical baffle **18** and the cylindrical casings for the particular unit in the annular flow path **18***a* formed therebetween. Thus, there is provided substantially integral units comprising fastening heads, carrier heads, T elements and coils which can be easily positioned inside the respective cylindrical casings **7***a*, **7***b*, etc.

Since the outlet T element **20** is also offset from the center or axial line of the cylindrical casings, sample cooler outlet lines **24***a*, **24***b*, etc. for each of the respective units will also be offset from the center or axial line of its respective cylindrical casing. A thimble **25***a*, **25***b*, etc. is provided for each unit in alignment with the offset position of the outlets **24***a*, **24***b*, etc. for the particular unit and these thimbles have threaded openings as at **26***a* into which is fitted a sealing means generally designated **27***a*.

The sealing means **27***a* includes a reducing nipple **28***a* which is threaded into the thimble **26***a*, a gasket **29***a* being provided for fluid tight connection therebetween. A bore **30***a* extends through the reducing nipple **28***a* and the bore has a diameter such that the outlet line for the particular unit is adapted to slidingly fit through the bore as is also illustrated in Figure 3 of the drawings.

The outlet end of the reducing nipple **28***a* is necked down slightly and is threaded to permit a sealing gasket **31***a* and a capping washer **32***a* threaded thereon to provide the desired fluid tight connection for sealing the bore **30***a*. In assembled position the pressure of the capping washer **32***a* deforms the gasket **31***a* into engagement with the outlet line **24***a* to provide the necessary fluid tight arrangement.

It will be understood that while only one unit is illustrated in Figure 3 that each of the units are identical therewith and hence have not been described or illustrated.

The exterior of each sample cooler unit inlet line **21***a*, **21***b*, etc. is provided with a socket weld connection as at **33***a*, etc. to provide means for connecting the specific unit to the respective points from which samples will be taken. Similarly, the sample cooler outlet lines are threaded to provide means for connecting these individual lines to the point, not shown, to which the samples will be taken for test.

In operation, the assembled sample cooler is connected to the sampling points and to the points to which the sampled liquid or steam will be led. In addition, the respective inlet **5** and outlet **6** are connected to a cooling water source so that cooling water enters the sample cooler through the inlet **5** and is discharged from the cooler through the outlet **6**. It is noted that the inlet **5** is larger than the outlet **6**, hence the sample cooler is kept full of cooling medium at all times or at least cooling fluid is directed into the sample cooler at a rate

greater than the ability of the sample cooler to discharge it.

By adjusting the diameter of the respective cylindrical casings **7***a*, **7***b*, etc., the inlet ports **8***a* and **9***a*, and **8***b* and **9***b* can be so sized that the amount of cooling fluid passing into and through each of the cylindrical casings **7***a*, **7***b*, etc. and out of the respective outlets **10***a*, **10***b*, etc. to the upper chamber **4** will flow at the desired rate for the particular size coil utilized and each sample cooler unit will thus always pass a standard sample to the point at which the tests will be made.

In the design of these units it is desirable to obtain a flow velocity of approximately 5 gallons per minute and thus the opening at the point of inlet through the cylindrical casings **7***a* and **7***b*, etc. is important. It controls the volume of cooling medium that passes upwardly through the cylindrical casings. The sizing of the inlets **8***a* and **9***a*, and **8***b* and **9***b*, will depend on the size of the inlet **5**. However, since the inlet ports **8***a* and **9***a* and **8***b* and **9***b* are relatively small, the construction permits a plurality of units to be provided in each sample cooler.

Second form of the invention

Figures 5 to 8 show a further form of the invention which also includes a cylindrical casing or shell **51** having a partition **52** thereacross to form a lower chamber **53** and an upper chamber **54**. The lower chamber **53** communicates with cooling water inlet **55** and the upper chamber **54** communicates with a cooling water outlet **56**. The partition **52** is provided with a plurality of openings as at **57***a*, **57***b*, etc. and about each of these openings an inner cylindrical baffle **58***a*, **58***b*, etc. is attached to the partition. These cylindrical baffles **58***a*, **58***b*, etc. extend upwardly and parallel to the center line of its respective openings **57***a*, **57***b*, etc. through the upper chamber **54** to a point short of the upper wall **59** of the upper chamber **54**. A second or outer cylindrical baffle as at **60***a* and **60***b* of greater diameter than said inner cylindrical baffles **58***a*, **58***b*, etc. is also attached to the partition **52** concentric to the respective inner cylindrical baffles **58***a*, **58***b* and like the baffles **58***a*, **58***b* also extend upwardly to a point short of the upper wall **59** just slightly higher than the inner cylindrical baffles **58***a*, **58***b*, as is shown in Figure 7 of the drawings. This arrangement of the inner and outer cylindrical baffles forms an annular space about each of the respective openings **57***a*, **57***b*, etc. which spaces receive sample cooler coil units generally designated M, N, etc. through the respective openings **63***a*, **63***b*, etc. in the upper head **59** in alignment with the openings **57***a*, **57***b*, etc. in the partition **52** and the concentric baffles.

Since all the coil units M, N, etc. are identical, only one coil unit is illustrated in Figure 7 of the drawings. Thus, Figure 7 shows the coil unit M as including a carrier head **62** and a support head **63** connected to each other. The carrier head **62** forms a shoulder as at **64** with the support head **63** and in assembled position snugly engages the opening **63***a* in alignment with its particular concentric baffle beween which the coil unit fits. A middle cylindrical baffle **65** is attached to the carrier head **62** and in assembled position as shown in Figure 7 extends downwardly concentric to and between the respective inner and outer cylindrical baffles **58***a* and **60***a*, respectively, to a point just short of the partition **52**. In this position the baffles **58***a*, **60***a* and **65** delineate an inlet flow passage **66**, a downward flow passage **67** and an upward flow passage **68**, and since all of the baffles have their respective ends remote from their attached ends open, the respective flow channels provide a sinuous or convoluted countercurrent flow path from the openings **57***a*, **57***b*, etc. in the partition to the open end of the respective outer cylindrical baffle or partition **60***a*, **60***b*, etc.

The sample liquid or vapor is cooled by flow through

a tubular coil shaped into a plurality of spiral coils arranged in an outer layer **69** and an inner layer **70** which are shown in Figures 7 and 8 in assembled position so disposed that the inner layer **70** is in the downward flow passage **67** and the outer layer **69** in the upward flow passage **68**. The tubular coils have inlets **71***a*, **71***b*, etc. and outlets **72***a*, **72***b*, etc. which are fixedly connected into their respective carrier and support heads by a suitable sealing and locking means as shown at **73** and **74** in Figure 7. The ends of the tubular coil inlets **71***a*, **71***b*, etc. and the tubular coil outlets **72***a*, **72***b*, etc. are provided with suitable means to connect the tubular coil to the point (not shown) in the system from which the sample liquid or vapor will be taken and to the point (not shown) where the cooled sample will be tested. Since the inlets communicate with the outer layer of coils and the outlets connect with the inner layer of coils the cooling fluid at its relatively lowest temperature will come in contact with the sample liquid or vapor passing through the sample cooler units at the point just before it is discharged into the outlets communicating with the point to which the sample is passed for testing. Thus, the sample to be tested will be delivered at the desired temperature assuming that the cooling water can be adjusted for this desired temperature.

As in the case of the form of the invention described with reference to Figures 1 to 4, the outlets **57***a* and **57***b* are also sized with respect to the downward flowing passage and the upward flowing passage to provide a rate of flow to bring the sample liquid or vapor to be tested to the desired temperature. In this form of the invention it is also desired to maintain a water velocity of approximately 5 gals. per minute.

In operation, the assembled sample cooler has its inlet **55** connected to a source of cooling water (not shown) and discharges this cooling water through the outlet **56**. In addition, each of the coil units has its respective inlets **71***a*, **71***b*, etc. connected to the point in the system from which samples will be taken and its outlets **72***a*, **72***b*, etc. connected to the point at which the samples will be tested.

The cooling fluid passes from the inlet **55** through the lower chamber **53** and openings **57***a*, **57***b*, etc. upwardly through the inlet passages formed in the inner cylindrical baffles **58***a*, **58***b*, etc.; thence through the respective downward flow passages **67** and upward flow passages **68** over the inner and outer layers **69** and **70** of the tubular coils. When it reaches the outlet of each of the outer cylindrical baffles **60***a*, **60***b*, etc. it discharges into the upward chamber **54** and then flows from the upper chamber to the outlet **56**.

Flow will be regulated to approximately 5 gals. per minute by adjusting the size of the openings **57***a*, **57***b*, etc. and in addition regulating the velocity of the cooling water as it is delivered to the lower chamber **53**.

In both this form of the invention and the form of the invention shown in Figures 1 to 4 the arrangement of the tubular coils permits the sizing of the tubular coil elements so that they can withstand high pressures and temperatures.

It will be understood that the invention is not to be limited to the specific construction or arrangement of parts shown but that they may be widely modified within the invention defined by the claims.

What is claimed is:

1. In a multi-unit sample cooler, a shell having a cooling water inlet and a cooling water outlet, a partition dividing said shell to form at least two chambers, one of said chambers communicating with said inlet and another of said chambers communicating with said outlet, a plurality of sample cooler coil units extending transversely of and in fluid tight relationship with said partition, each of said sample cooler coil units including a flow passage means to pass cooling water across said sample cooler coil unit from said inlet chamber to said outlet chamber, and means connected to the flow passage means to provide a predetermined rate of flow therethrough.

2. In a multi-unit sample cooler, a shell having a cooling water inlet and a cooling water outlet, partition means dividing said shell into at least two chambers, one of said chambers communicating with said inlet and another of said chambers communicating with said outlet, a plurality of sample cooler coil units detachably mounted in said shell in spaced relation transversely of said partition, said sample cooler coil units each having an inlet and an outlet for sampled fluid to be cooled, and flow passage means about each of said units to pass cooling water from at least one of said chambers to the chamber communicating with said cooling water outlet, and means connected to the flow passage means to provide a predetermined rate of flow therethrough.

3. In a multi-unit sample cooler, a shell having a cooling water inlet and a cooling water outlet, partition means dividing said shell into at least two chambers, one of said chambers communicating with said inlet and another of said chambers communicating with said outlet, a plurality of flow passage means disposed transversely of said partition in spaced relation to each other, said flow passage means having an inlet to receive cooling water from at least one of said chambers and an outlet to pass cooling water to said chamber connected to the cooling water outlet, a sample cooler coil unit removably positioned in each of said flow passage means, said coil unit having an inlet to receive fluid to be sampled and an outlet for said sampled fluid, and the inlet of said flow passage means constructed and arranged to provide a predetermined volume of cooling water passing through said flow passage means.

4. In a multi-unit sample cooler, an elongated shell having a cooling water inlet and a cooling water outlet, partition means dividing said shell into at least two chambers, a plurality of flow passage means disposed transversely of said partition in spaced relation to each other, said flow passage means having an inlet to receive cooling water from at least one of said chambers and to pass cooling water to the chamber connected to the cooling water outlet, a plurality of openings on said shell in alignment with said flow passage means, a sample cooler coil unit removably mounted in each of said openings and disposed to fit in the respective aligned flow passage means associated with said opening, said coil unit having an inlet and an outlet for sampled fluid, and the inlet end for each of said flow passage means constructed and arranged to provide a predetermined volume of water passing therethrough.

5. A multi-unit sample cooler as claimed in claim 4 wherein each of said sample cooler coil units include a carrier head, and a baffle connected to said head, said baffle in spaced relation to said flow passage means in assembled position to define the flow passage and direct its flow over the sample cooler coil units.

6. A multi-unit sample cooler as claimed in claim 5 wherein the inlet end of said flow passage means has the plane of its periphery normal to the flow passage means axis, and said inlet means is adapted to coact with a portion of the shell wall to provide the proper opening for providing the desired volume of cooling water passing therethrough.

7. A multi-unit sample cooler as claimed in claim 4 wherein each of said sample cooler coil units include a carrier head and a baffle connected to said head, said flow passage means including an inner partition and an outer partition, and said baffle means in assembled position disposed between said inner and outer partitions to provide a convoluted path for fluid flow.

8. In a multi-unit sample cooler, a shell having a cooling fluid inlet and a cooling fluid outlet, a partition dividing said shell into an upper chamber and a lower

chamber, said lower chamber communicating with the cooling fluid inlet, said upper chamber communicating with the cooling fluid outlet, and a plurality of sample cooler coil units mounted in said shell in spaced relation, each of said units including, flow passage means connected transversely of and in fluid tight connection with the partition, said flow passage means having an inlet end in communication with said lower chamber, and an outlet end in communication with said upper chamber to pass cooling fluid thereto, and coil means fitted in said flow passage means and detachably connected to said shell, said coil means each having an inlet for receiving fluid to be sampled and an outlet for the cooled sampled fluid, and the inlet means for said flow passage means constructed and arranged relative said shell to provide a predetermined volume of cooling fluid passing through said flow passage means.

9. In a multi-unit sample cooler, a shell having a cooling fluid inlet and a cooling fluid outlet, a partition dividing said shell into an upper chamber and a lower chamber, said lower chamber communicating with the cooling fluid inlet, said upper chamber communicating with the cooling fluid outlet, said partition having a pluraltiy of openings therein, an inner cylindrical partition

about each opening extending upwardly from said partition a predetermined distance, an outer upwardly extending cylindrical partition connected to said partition concentric to said inner cylindrical partition to form an annular space therewith, sample cooler coil units mounted in said shell and disposed to extend into each of said annular spaces, each of said units including, a head, a coil connected to said head having an inlet and an outlet for fluid to be sampled, and a baffle connected to said head, said baffle disposed in assembled position to extend downwardly between said inner and outer partitions to provide a convoluted flow path for cooling fluid as it passes over said coil units, and said opening including means to provide a predetermined volume of cooling fluid to be passed through said sample cooler unit.

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