Sept. 16, 1969 J. F. RAMPE 3,467,319

LIQUID-COOLED PROCESSING VESSEL

Filed Aug. 25, 1966 2 Sheets-Sheet 1

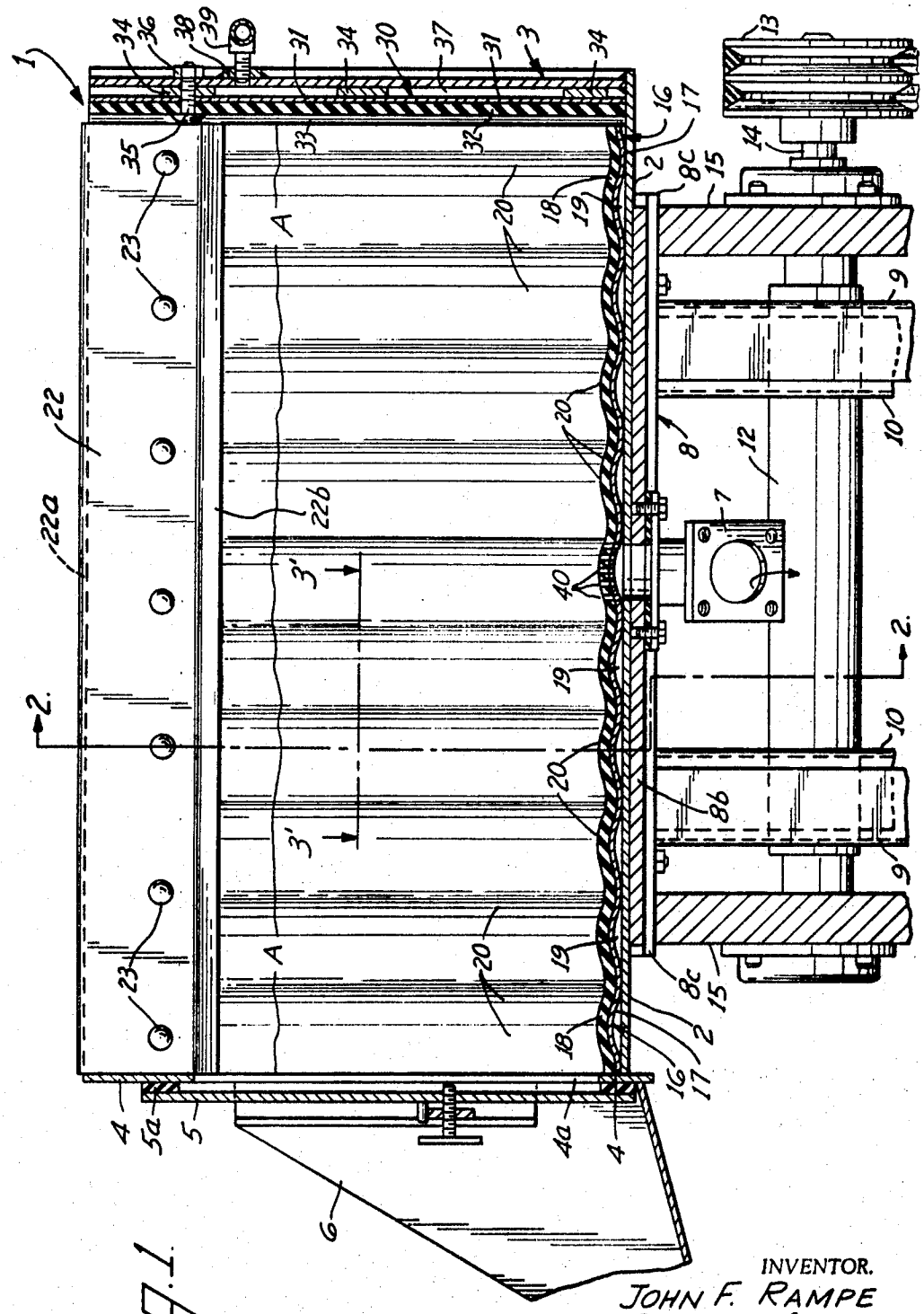

Fig. 1

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Fig. 2.

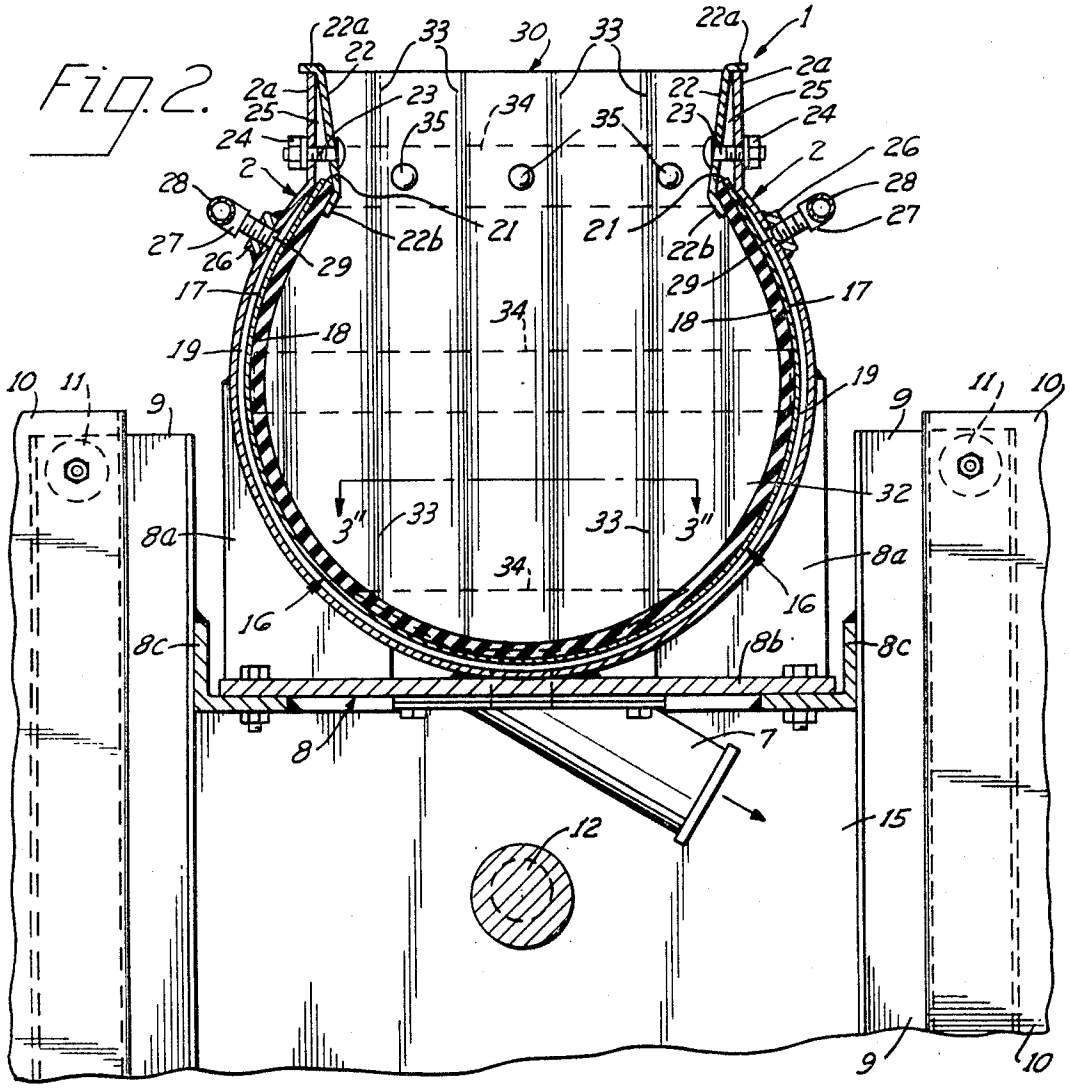


Fig. 5.

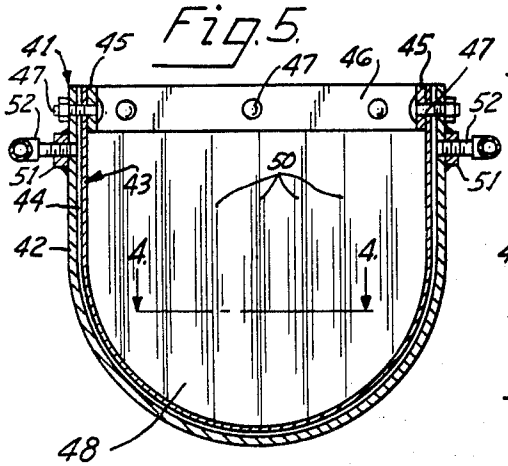


Fig. 3.

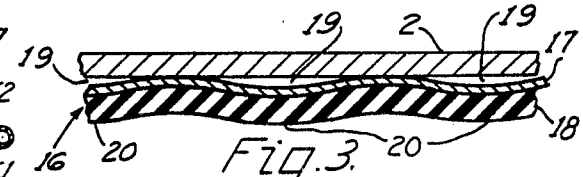
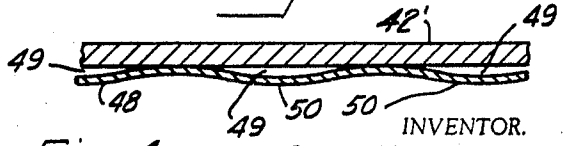


Fig. 4.



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LIQUID-COOLED PROCESSING VESSEL

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U.S. Cl. 241—67 15 Claims

ABSTRACT OF THE DISCLOSURE

A liquid-cooled processing vessel comprising a shell having body and end portions; transversely extending end pieces at the end portions of the shell; a sleeve of abrasion-resistant material loosely suspended within the body portion of the shell between the end pieces; a panel of abrasion-resistant material loosely lining one of the end pieces; means for introducing a cooling liquid into the shell; and means facilitating orderly flow of the cooling liquid behind the abrasion-resistant material.

This invention relates to the liquid-cooling of tubs, drums and similar processing vessels such as are to be found, for example, in orbital finishing machines; in certain types of rod, ball and pebble mills; and, among others, in rock mills and the like.

All of these machines have in common the fact that what they hold in the way of contents, charge or load is subjected to tumbling, vibration, agitation or some similar form of physical displacement. While the usefulness of the invention is not confined to a particular type of machine, it will nevertheless be described, for convenience, in terms of modern finishing machines of the orbital type. The latter vibrate the contents of the tub in orbital fashion and are the subject, inter alia, of prior Patents Nos. 3,191,347, 3,191,348 and 3,231,093 to John F. Rampe.

It is known, feasible and in some instances routine practice to cool heavy-duty processing equipment (crushers, granulators, pulverizers and the like) by superimposing on the basic structure an external water jacket of one kind or another, but in the past relatively little productive consideration has been given to techniques and means for effectively cooling the peripheral portions of tubs of the type employed in orbital finishing machines. In the latter, the tub in which finishing operations are performed is often coated interiorly with a thick lining of an elastomeric material such as vulcanized rubber, a rubber-like polymer or a plastisol residue. Such coatings are usually regarded as adequately resistant to impact and abrasion at temperatures more or less of the order of normal room temperatures, but under difficult operating conditions, particularly where elevated temperatures are developed, they manifest a tendency to deteriorate with time.

The present invention contemplates, among other things effectively cooling the basic structure of the tub and liner, not so much by superimposing a cooling jacket on the shell as by the incorporation in the shell of means associated with the liner for circulating a liquid coolant between the shell and the liner. Composite liners of certain types that have come into use in the rather recent past, particularly liners taking the form of steel-backed sheets of rubber or rubber-like materials, lend themselves to modification by the use of techniques that are presently available. When structurally modified as contemplated by the present invention, they may be employed to the end of utilizing the liner itself as a part of the coolant circulating system.

Thus the invention may be said to have for one of its objects to provide, for use in a finishing machine or the like, a liquid-cooled processing vessel equipped with replaceable cooling means consisting largely or entirely of a composite liner of high impact abrasion and resistance.

The preferred embodiment of the invention involves the use of a structurally modified liner consisting primarily of high performance rubber permanently bonded to a steel backing member. However, it is also feasible to use a structurally modified metal liner without any covering layer of rubber or the like, provided the metal used for the purpose is itself adequately resistant to impact and abrasion.

In both cases, the metal used in or as the liner should be tough, strong and fairly easily shaped; however, in most instances, at least in the case of the presently available types of abrasion-resistant sheet steel, it need not be of a thickness greater than approximately 1/16 of an inch. Whether used with or without a covering sheet of high-performance rubber, it may advantageously and will usually be of a tough ferrous metal alloy lending itself to rolling, bending and shearing on conventional metal working equipment. Sheet steel of the desired characteristics is available on the commercial market at the present time.

Other objects, advantages and features of the invention will be apparent from the description which follows and from the accompanying drawings, in which:

FIGURE 1 is a central vertical longitudinal section through the upper part of an orbital finishing machine including a processing vessel taking the form of a drum-shaped tube provided with a structurally modified liner conforming to the present invention;

FIGURE 2 is a transverse section seen as if from line 2—2 of FIGURE 1;

FIGURE 3 is an enlarged fragmentary section on line 3'—3' of FIGURE 1;

FIGURE 4 is an enlarged fragmentary section of like nature illustrating the manner of use of an all-steel liner without a covering sheet of rubber or the like; and

FIGURE 5 is a reduced-scale section, generally similar to the section appearing in FIGURE 2, through a processing tub the upper half of which is non-cylindrical.

Illustrated generally at **1** in FIGURES 1 and 2 is an open-top tub of oblong shape characterized, among other things, by a body portion consisting of a generally cylindrical steel shell **2**. The long sides of shell **2** extend upward to form the vertical flanges **2***a* seen in FIGURE 2. At the right hand end of the tub, seen as in FIGURE 1, a flat steel end piece **3** conforming in shape to the transverse section of the shell is welded to the end portion of the shell. The top edges of flanges **2***a* define the two sides and the top edge of end piece **3** defines one of the two ends of the top opening in the tub.

At the opposite end of tub **1**, likewise welded to shell **2**, is a generally simiar steel end piece **4** provided with a large discharge opening **4***a*, a sturdy door **5**, a door gasket **5***a*, and a permanently attached discharge chute **6**.

At the bottom of tub **1** will normaly be an opening or sump of suitable shape and size and an underlying drain assembly **7** (see FIGURE 1). Cooling water introduced into the interior of tub **1** as hereinafter explained is permitted to flow therethrough into drain assembly **7** and thence into a sewer or, if desired, into a conduit leading to a system for cooling, filtering and temporarily storing the water preparatory to re-using it as a coolant. Finishing media, work pieces and entrained water, on the other hand, are normally discharged through end opening **4***a* and chute **6**.

A heavy steel cradle **8**, best seen in FIGURE 2, is welded to and supports tub **1**. Cradle **8** consists of a plurality of steadying pieces **8***a*, one or more longitudinally extending members **8***b*, and two longitudinally extending angles **8***c*. The latter are bolted to members **8***b* and welded to uprights **9**, which, together with cradle **8**, form part of the vibratory structure; i.e., that portion of the machine which is vibrated in the normal course of its operation.

Uprights **9** are carried by and adapted to move in relation to stationary uprights **10**, four of which form part of the frame of the machine. Uprights **9** and **10** are connected through mounting assemblies **11** of the rubber-in-shear type, of which there are two at each end of cradle **8**. Eccentric shafting **12**, coupled to and driven from pulley **13** and pulley shaft **14**, is employed to impart the desired vibratory movement to such components as members **15**, uprights **9**, cradle **8** and tub **1**.

In the operation of an orbital finishing machine of the type so far described, the finishing media, the objects to be finished ("work pieces"), and the treating liquid ordinarily introduced with them into the tub produce a load line that is often as high as, or even higher than, line A–A in FIGURE 1. In consequence, nearly all portions of any elastomeric coating on the inside surface of the tub or forming a portion of a replaceable liner, if one is used in it, are subjected to the severe abrading action of the tub contents, the dynamic action of the work pieces as they rise and fall within the mass, and hysteresis-induced temperature changes in the coating itself. The latter factor alone may result in skin temperatures approaching the temperature of boiling water. In these circumstances, it is not difficult to understand why almost any elastomer will tend to soften, deteriorate and require replacement.

In effect, the present invention provides a water-cooled interior shield in the form of a replaceable sleeve or replaceable panel conforming fairly closely to the contour of the surface on which it is used. Its use serves to overcome some of the most troublesome of the above-described problems. In the case of the tub shown in Figures **1** and **2**, such interior shield takes both forms; i.e., that of a sleeve-like element **16** which serves to line the side walls of the tub and that of a panel which serves to line end piece **3**. The former is usually the more important and therefore is likely to be present even though, in a given case, the latter may be lacking.

Sleeve **16** is best seen in FIGURE 2. It is comprised of a composite material consisting of a metal backing sheet **17** of 16-gauge impact- and abrasion-resistant sheet steel to which is permanently bonded a thick covering sheet or coat **18** of high-performance rubber; i.e., rubber characterized, among other things, by a marked ability to resist abrasion. The overall thickness of the composite material, hereinafter referred to simlpy as the liner, can to advantage be about one-half inch. The rubber layer can to advantage be about seven times as thick as the backing sheet. However, the thickness ratio may be greater or less than seven to one and the overall thickness may be less or more than one-half inch.

As indicated in FIGURE 3, sleeve-like shield **16** fits more or less loosely within shell **2**. This somewhat loose fit results in part from the fact that metal backing **17**, and therefore rubber layer **18**, is of undulating shape. The liner as produced is ordinarily flat, requiring that it be "worked" to give it the undulating appearance shown in FIGURES 1 and 3. The undulating shape in turn gives rise to voids and ridges that for present purposes can best extend radially; i.e., transversely of the longitudinal axis of shell **2**. Provided the liner is worked as described, rolled into a sleeve, and introduced endwise into shell **2**, spaces **19** and ridges **20** will define and act as peripherally oriented water courses making for orderly flow of the water employed in cooling the walls of the tub.

Referring to FIGURE 2, sleeve-like shield **16** terminates and thus has longitudinally extending edges at **21** just above the zones in which the cylindrical body portion of shell **2** gives way to vertical flanges **2***a*. In this vicinity sleeve-like shield **16** can conveniently be suspended from its top, producing the above-described loose fit within the shell. The top portions of the shield are clamped in place and to some extent supported by two longitudinally extending clamping strips **22**, one on each side of shell **2**. Strips are provided with angled end portions **22***a* and **22***b* of which the former extend over the top edges of flanges **2***a* and the latter strike downward into engagement with sleevelike shield **16**. Each of the two clamping strips is held in place by a series of bolts **23** and nuts **24**, which, when urged toward each other, do not close completely but leave the voids indicated at **25** behind clamping strips **22**.

In copending application Ser. No. 705,646 several such clamping systems are shown and described in detail.

On each of the two opposite sides of shell **2** a series of small mounting pieces **26** is welded to the outer surface of the shell. The number in each of the two series will depend on the length of the shell: in typical cases there may be from a half dozen to a dozen. In preparing them, each mounting piece is drilled through from top to bottom and tapped to enable it to accommodate the threaded hollow stem of a fitting **27** that is essentially of the nature of an elbow: see FIGURE 2. A conduit (not shown) serves as a common source of cooling water: it communicates with the inlets **28** in the several fittings.

Water from this source proceeds into inlets **28**, into and through the threaded shanks of fittings **27**, and into openings **29** in the wall of shell **2**. Mounting pieces **26** and fittings **27** are preferably so located that they lie outward of ridges **20**; i.e., behind transversely extending spaces **19**. If so, the cooling water can travel downward by gravitational action virtually immediately upon entering the shell. However, lateral travel of the cooling water behind shield **16** is by no means precluded, particularly when the cooling water is under moderate pressure, as is usually the case.

At the end of the tub appearing at the right in FIGURE 1 is a smaller shield **30** of the panel type the shape of which corresponds to the shape of the end portion of the tub. It is suspended toward its top from the upper portion of end piece **3**. Like sleeve-like shield **16**, it is characterized by undulations. For some purposes and in a broad sense it may be thought of as flat. From FIGURE 2 it will be seen to consist of a metal backing sheet **31** to which is bonded a layer **32** of rubber. It is characterized by vertical ridges **33** behind which are vertical spaces adapted to serve as water courses.

Transversely mounted spacing strips **34**, three in number, are located where indicated by the transverse dotted lines appearing in FIGURE 1. Bolts **35** and nuts **36**, the former of which pass through the uppermost of the spacing strips, serve to hold panel-like shield **30** in place in a manner permitting it to hang it more or less loosely. Cooling water entering through mounting pieces **38** and fittings **39** tends to fill voids **37** between the spacing strips behind panel-like shield **30**, which voids act as headers or distributors to facilitate orderly flow of the cooling water.

At the bottom of tub **1**, sleeve-like shield **16** is provided with a group of small openings **40** overlying the large drain opening immediately above drain assembly **7**. Because shields **16** and **30** are loosely suspended within the shell, cooling water finding its way into the spaces behind the ridges tends to make its way without undue difficulty into and out of the central portion of the tub. That part of the cooling water which courses downward behind sleeve-like shield **16** readily escapes through fitting **7**. That part which enters through end piece **3** proceeds to the bottom of shell **2** by following whatever path it finds it easiest to take. If it flows into sleeve-like shield **16**, as it can do, drain holes **40** facilitate its escape into drain assembly **7**.

FIGURE 3, as already pointed out, represents a section on line 3′—3′ of FIGURE 1. Except as to the various reference characters, it could serve equally well to represent a section taken on line 3″—3″ of FIGURE 2. The reason resides in the fact that the undulating shape to which reference has already been made is characteristic not only of sleeve-like shield **16** but also panel-like shield **30**. FIGURE 4, on the other hand, deals with a closely related modification described below and illustrated in FIGURE 5.

In the modified form of tub shown on a reduced scale in FIGURE 5, the portions of shell **42** above a horizontal plane passing through its major axis extend vertically upward, imparting a generally U-shaped appearance to the cross section and giving the tub as a whole a somewhat greater capacity. Suspended from the upper portions of shell **42** is a loosely hanging sleeve-like shield **43** of undulating contour of high resistance to impact and abrasion. Although sleeve-like shield **43** may for certain purposes be covered by a thick layer of an elastomer such as rubber of the high-performance type, it is sometimes entirely satisfactory to make use of metal with no overlying coating. The undulations form downwardly-directed water courses **44** extending transversely of the longitudinal axis of the tub.

In the tub shown in FIGURE 5, the clamping system includes, in addition to bolts **47**, clamping strips **45** and **46**, the former extending laterally along the long sides of the tub opening and the latter at right angles thereto at the end appearing in FIGURE 5. Bolts **47** hold the clamping strips and shield to shell **42**. At the end corresponding to the end seen in FIGURE 2 is a panel-like shield **48**, likewise of metal of undulating contour, corresponding in shape to the shape of the end portion of the tub (**42'**). As indicated in FIGURE 4, panel **48** is characterized by ridges **50** and spaces **49** through which cooling water may flow to the bottom of the tub. The external system for supplying cooling water to the sides and end of the tub is the same as that shown in FIGURES 1 and 2.

It is evident that modifications of what has already been described may be made by those skilled in the art without departing from the spirit of the invention. For example, the ridges and spaces characterizing the sleeve-like shield may, if desired, be so oriented as to extend parallel to rather than transversely of the major axis of the vessel. If so, the system for supplying and withdrawing cooling liquid can use annular headers, one at each end of the vessel, with the cooling liquid flowing from one to the other in courses delineated by the spaces behind the ridges. Other changes of generally similar nature may be expected to suggest themselves to those skilled in the art to which the invention relates.

It is intended that the patent shall cover, by summarization in appended claims, all features of patentable novelty residing in the invention.

What is claimed is:

1. A liquid-cooled processing vessel comprising a shell having body and end portions; end pieces at the end portions of the shell; a shield of abrasion-resistant material loosely suspended in spaced relation to the shell between the end pieces; means for introducing a cooling liquid into the shell; and means directing the cooling liquid through and confining it to the space between the shield and the shell.

2. A processing vessel according to claim **1** wherein the shield takes the form of a liner characterized by a multiplicity of ridges standing away from the wall of the vessel and a multiplicity of spaces behind them serving as courses for the cooling liquid.

3. A processing vessel according to claim **2** wherein the ridges and associated spaces extend in a direction generally parallel to the longitudinal axis of the vessel.

4. A processing vessel according to claim **2** wherein the ridges and associated spaces extend transversely of the major axis of the vessel.

5. A processing vessel according to claim **4** wherein the liner takes the form of a panel the general plane of which extends normally to the major axis of the vessel.

6. A processing vessel according to claim **4** wherein the liner takes the form of a sleeve the longitudinal axis of which substantially coincides with the major axis of the vessel.

7. A liquid-cooled tub having body and end portions; transversely extending end pieces at the end portions of the tub; a sleeve-like shield of abrasion-resistant material loosely suspended within the body portion of the tub; means for introducing a cooling liquid into the interior of the tub; and means facilitating the orderly flow of cooling liquid between the shield and the tub.

8. A tub according to claim **7** wherein the shield takes the form of a liner characterized by elongated ridges with correspondingly shaped spaces behind them that serve as courses for cooling liquid.

9. A tub according to claim **8** wherein the ridges follow around the periphery of the tub along paths that extend transversely of its major axis.

10. A liquid-cooled processing tub; transversely extending end pieces attached at end portions of the tub; a suspended panel-like shield of abrasion-resistant material loosely lining one of the end pieces; means for introducing a liquid coolant into the tub; and means facilitating the flow of cooling liquid between the shield and the tub.

11. A processing tub according to claim **10** wherein said panel-like shield is characterized by elongated ridges with correspondingly shaped spaces behind them that serve as courses for the cooling liquid.

12. A processing tub according to claim **11** wherein the ridges are vertically oriented in said panel-like shield.

13. A liquid-cooled processing vessel comprising a shell having body and end portions; end pieces at the end portions of the shell; abrasion-resistant material in sleeve form loosely suspended from the shell between the end pieces; abrasion-resistant material in panel form loosely suspended from at least one of the end pieces; means for introducing a cooling liquid into the shell; and means facilitating the orderly flow of cooling liquid between the shell and the abrasion-resistant material lining the shell.

14. A processing vessel according to claim **13** wherein the abrasion-resistant components take the form of liners of undulating shape.

15. A processing vessel according to claim **14** wherein the liners consist of sheet steel backing material overlaid with a coating of a rubber-like elastomer of high performance characteristics.

References Cited

UNITED STATES PATENTS

628,499	7/1899	Sutphen	241—67 X
1,728,496	9/1929	Lindhard	241—67 X
3,204,881	9/1965	Parten	241—66
3,333,367	8/1967	Salvaire	51—314 X

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U.S. Cl. X.R.

241—182; 220—13; 51—356, 314