United States Patent

[11] 3,590,407

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[45] Patented **July 6, 1971**
[73] Assignee **Mobil Oil Corporation**

[54] **SWIVEL TANKER FLOATING STORAGE SYSTEM**
1 Claim, 2 Drawing Figs.

[52] **U.S. Cl.** **9/8,** 114/.5
[51] **Int. Cl.** **B63b 21/50**
[50] **Field of Search** ..... 9/8; 114/0.5 D; 166/0.5, 0.6

[56] **References Cited**

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3,407,768	10/1968	Graham	9/8
3,472,032	10/1969	Howard	9/8

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Assistant Examiner—Steven W. Weinrieb
Attorneys—William J. Scherback, Frederick E. Dumoulin, Paul Van Slyke, Andrew L. Gaboriault and Sidney A. Johnson

ABSTRACT: The specification discloses a fluid storage system which includes a floating storage vessel having a swivel assembly mounted in its bow structure. The stationary core of the swivel assembly is moored to the water bottom by means of anchor lines extending through hawse tubes, while the storage structure is free to pivot about the stationary core in response to the combined forces of wind and water. Mounted centrally in a hollow portion of the stationary core of the swivel assembly is a liquid-gas separator unit. The liquid and gas outputs of the separator unit pass through swivel joints to the storage tanks of the floating structure. The separator unit comprises a main pressure vessel and a surge vessel which absorbs shock loads from the riser flowlines.

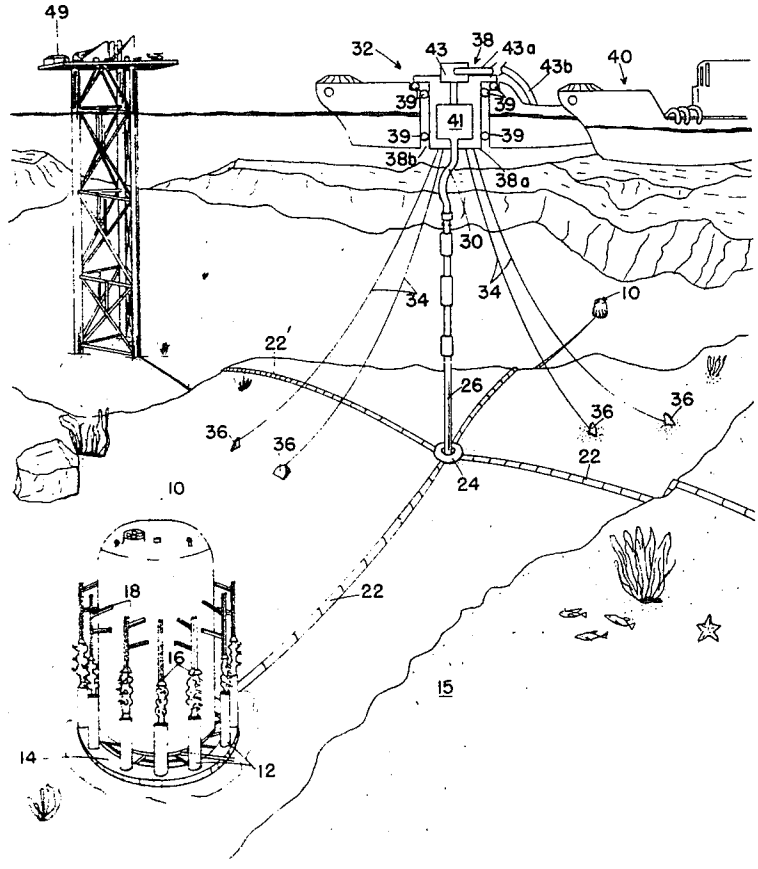
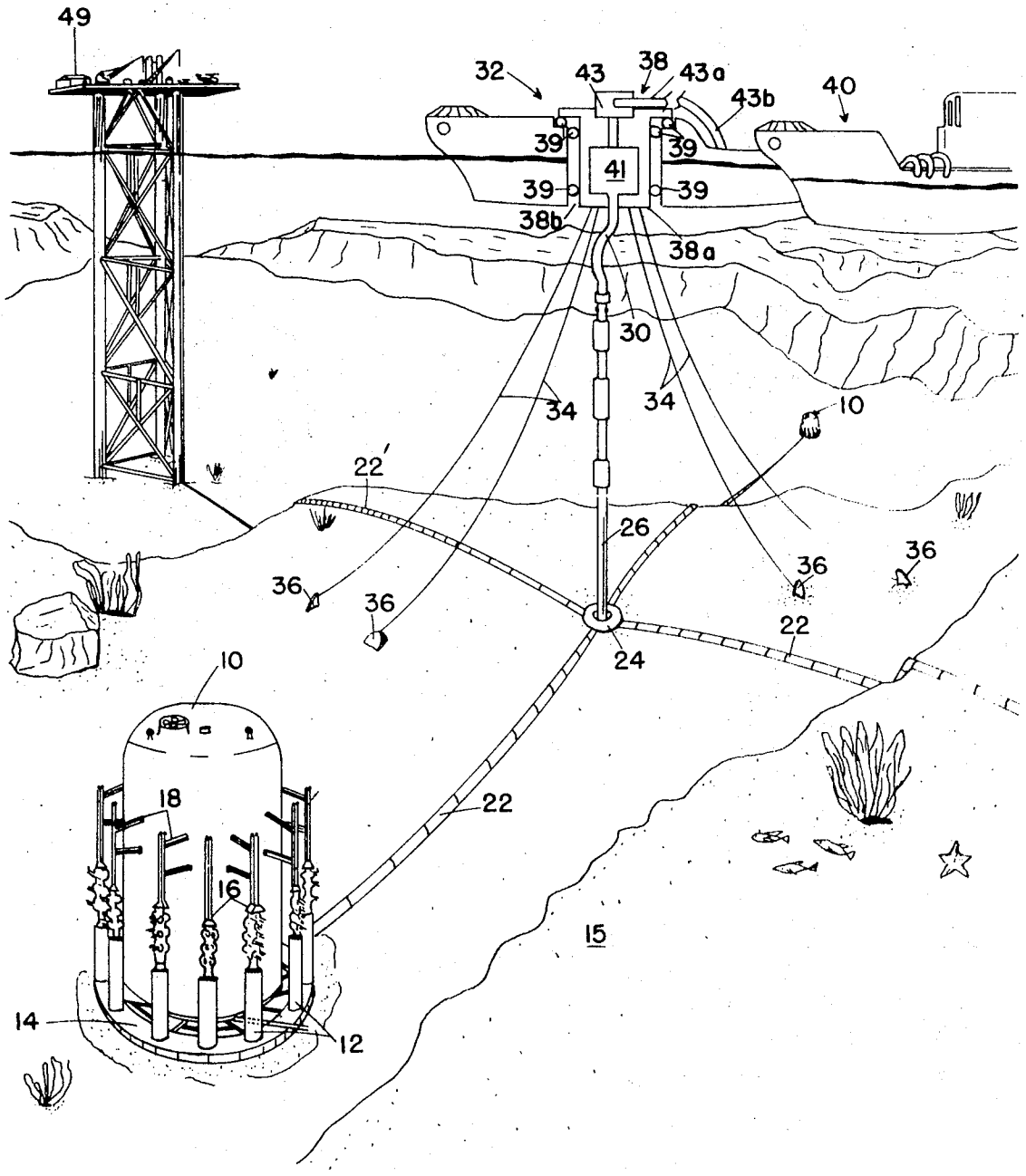


Fig. 1


49
32
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38
43a
43b
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41
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38a
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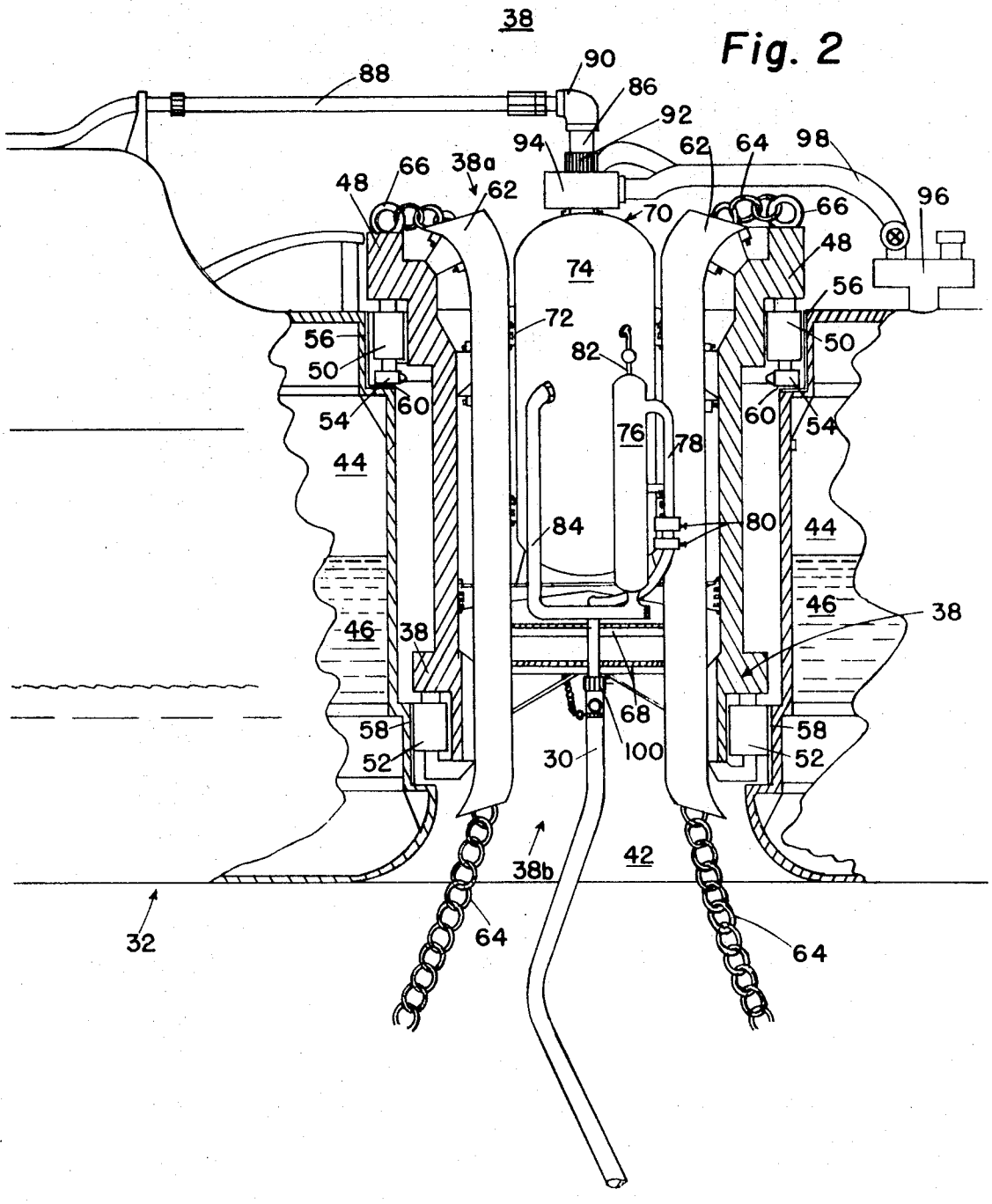
Fig. 2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SWIVEL TANKER FLOATING STORAGE SYSTEM

FIELD OF THE INVENTION

The invention described herein relates generally to the production and storage of fluid minerals, such as oil and gas, underlying a body of water.

SUMMARY OF THE INVENTION

The present invention provides a novel and improved system which:

1. Enables economical and efficient storage of fluid minerals underlying a body of water to wind a surface storage location using a minimum of parts and equipment;
2. Permits a floating storage structure to pivot about a mooring point in response to wind and water forces; and
3. Eliminates high pressure seals in swivel joints in the production flowline.

In accordance with the present invention there is provided a system including a floating storage structure having a ship-shaped hull and a swivel assembly mounted in the bow structure along the longitudinal axis. The swivel assembly includes a stationary core which is journaled in a vertical well in the floating storage structure. In use, the storage structure is positioned over a submarine production site and the stationary core of the swivel assembly is moored by mooring lines to the water bottom. A flowline including a flexible connection extends from bottom gathering points for the fluid minerals to the stationary core of the swivel assembly. The stationary core includes a separator unit for dividing the fluid minerals into liquid and gaseous components and reducing each component to atmospheric pressure. A swivel joint is coupled to the top of the stationary core and is in communication with the liquid outlet of the separator unit. The outlet of the swivel joint is connected by a flowline to the liquid storage tanks in the floating storage structure. The gas component from the separator unit may be flared by means of a flare stack mounted atop the stationary core or passed through a separate swivel joint to pipelines or other destinations.

Since the stationary core of the swivel assembly is moored by the anchor lines to the bottom, the floating storage structure is free to pivot about the stationary core in response to wind and water forces in the manner of a weather vane. Since the liquid component is reduced to atmospheric pressure in the swivel assembly, the swivel joint may be of less expensive design and tends to be more trouble-free than if no preswivel joint separation had been performed.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 1 is a schematic illustration of one form OF the present invention used in conjunction with an underwater satellite gathering system; and

FIG. 2 is a side elevational view partially broken away of one form of the swivel assembly and separator for use in the system of FIG. 1.

DETAILED DESCRIPTION OF FIG. 1

Referring to FIG. 1, a production system is shown utilizing a number of submarine satellite gathering stations **10**, each having a series of wells drilled through standing conductor pipe elements **12** of a template ring **14** resting on the marine bottom **15**. The wells are all completed with subsea wellheads **16** mounted atop the conductor pipes **12** and are in turn capped with connector units **18** for directing the produced fluids from the wellheads into the interior of the satellite gathering stations **10**. The apparatus and method of installation of such subsea satellite gathering stations are described in the copending application Ser. No. 740,520, filed June 27, 1968, to William A. TAlley, Jr., and entitled "Subsea Production Station."

The output flow of all of the satellite gathering stations **10** is connected through shipping lines **22** to a circular manifold **24**, located on the marine bottom **15** concentric with a tether pipe **26**. Produced fluids are transported through the tether pipe **26** from the marine bottom **15** to the upper end of pipe **26** several hundred feet below the water surface. A flexible line **30** extends from the upper end of the tether pipe **26** to a floating storage structure **32** having a ship-shaped hull. Floating storage structure **32** includes a swivel assembly **38** mounted in its bow structure. Swivel assembly **38** comprises a stationary core **38*a*** journaled in a vertical well **38*b*** extending through structure **32**. The floating structure **32** is moored over tether pipe **26** by means of mooring lines **34** extending between anchor points **36** on the marine bottom **15** and stationary core **38*a***. A transport tanker **40** is illustrated as tied alongside storage structure **32** while stored fluid is offloaded onto tanker **40**.

The swivel assembly **38** is located along the longitudinal centerline of storage structure **32**, preferably in the forward 20 percent of the length of structure **32**. Stationary core **38*a*** is shown schematically as being mounted on bearings **39** so that it is freely rotatable within vertical well **38*b***.

Stationary core **38*a***, being moored by means of anchor lines **34**, remains fixed while the floating storage structure **32** may pivot in the manner of a weather vane. In this manner, floating storage structure **32** can always be pointed into the direction of wind and waves.

A rotatable propulsion unit may be mounted in the stern of structure **32** to aid in controlling the position of structure **32**.

Mounted on the stationary core **38*a*** is a separator unit **41** for separating the production flow into its gaseous and liquid components. An oil swivel joint **43** is shown mounted atop the swivel assembly **38** and is connected to the liquid outlet of separator unit **41**. The outlet pipe **43*a*** of swivel joint **43** is connected by means of a storage line **43*b*** to the storage tanks located in storage structure **32**.

By having a liquid-gas separator **41** mounted in the swivel assembly **38**, only low pressure fluids must be directed through the inherently more vulnerable swivel joint **43**, thereby lessening the possibility of leakage and/or permitting the use of less expensive swivels. The high pressure fluids from underwater need pass through only nonswivel, high pressure connections to the separator unit **41**.

A platform **49**, having an above-surface deck, is shown supported on a shallower portion of marine bottom **15** where the water is not deep enough to justify use of a satellite gathering system. Platform **49** is also linked to storage structure **32** by means of a flowline **22'** interconnecting gathering equipment on platform **49** and the manifold **24** at the base of tether pipe **26**. The use of the floating storage structure **32** in conjunction with platform **49** permits the platform to be considerably lighter construction than if a storage facility were built in to platform **49**. In addition, the elimination of the offloading facility from platform **49** reduces the loads for which the platform must be designed.

DETAILED DESCRIPTION OF FIG. 2

FIG. 2 illustrates a specific design for the swivel assembly **38** and separator **4** of FIG. 1 which is disclosed in the copending application Ser. No. 775,241, filed Nov. 13, 1968, to William A. Talley, Jr., and entitled "Swivel and Separator Assembly for Floating Vessel."

Referring to FIG. 2, the swivel assembly **38** comprises a stationary core **38*a*** which is rotatably mounted within vertical well **38*b***. Stationary core **38*a*** includes an outer frame **48** having upper and lower axial roller bearing sets **50** and **52**, respectively, and a set of radial thrust bearings **54**. The axial roller bearings **50** and **52** bear on circumferential wear plates **56** and **58**, respectively, which are mounted in recesses in the wall of vertical well **38*b***. The set of thrust bearings **54** bears on a ring wear plate **60** fixedly mounted on a horizontal ledge in the upper portion of vertical well **38*b***.

The entire stationary core 38*a* can be removed from vertical well 38*b* by a derrick or crane, after the various fluid and anchor lines have been disconnected, by merely lifting the assembly straight up out of the vertical well.

Hawse tubes 62 displaced at angular intervals extend vertically through the central bore in stationary core 38*a*. A number of mooring chains 64, anchored in the marine bottom, extends up through the body of water into the hawse tubes 62 from which they emerge at the upper end of stationary core 38*a* and are connected to padeyes 66 on outer frame 48.

Mounted within the central bore of stationary core 38*a*, above a pair of walkaround platforms 68 an within the hawse tubes 62, is a low temperature separator 70. Separator 70 is securely fixed within stationary core 38*a* by bolted flange connection 72 mounted between the outer face of main pressure vessel 74 of separator 70 and the hawse tubes 62. The separator equipment within the main pressure vessel 74 is similar to that found in many other low temperature separator units and includes inlet deflectors, stilling baffles, a two-phase float valve, and a mist extractor.

Mounted on the outer face of the main pressure vessel 74 is an auxiliary surge vessel 76. The inlet of surge vessel 76 is connected by a rigid inlet pipe 78 with the upper end of flexible line 30. The oil and gas mixture raising through the tether pipe 26 and the flexible line 30 often has discrete volumes of gas followed by volumes of oil. Such discontinuous fluid flow produces extreme shock loads when arriving at the terminus of its transportation path. The purpose of the surge vessel 76 is to accept such shock loads that could damage the main pressure vessel 74. While the surge vessel 76 includes no special equipment, it does tend to cause a substantial vertical separation of the gas from the oil. For this reason the gas line 82 is provided from the upper end of surge vessel 76 for conducting mostly gas into the main pressure vessel 74 below its mist extractor. An outlet pipe 84 connects the lower end of surge vessel 76 with an inlet port midway up the main pressure vessel 74.

Final separation of the oil-gas mixture occurs within the man pressure vessel 74, the gas being removed from the main pressure vessel 74 through a central upstanding pipe 86 connected to a gas outlet line 88 by a right angle swivel joint 90.

The oil separated out of the produced fluid is removed from the main pressure vessel 74 through a swivel joint comprising a concentric pipe 92 enclosing the lower end of the upstanding pipe 86 and an outer concentric swivel yoke 94 rotatably mounted thereon. The outlet of yoke 94 is connected to a storage manifold 96 by an oil outlet 98. The oil directed to the manifold 96 is transported down into the storage compartments 44. The gas flowing in line 88 will usually be pumped to shore through a submarine pipeline, will be compressed and stored in another unshown tank in storage structure 32, will be reinjected into subsurface formations, and/or will be flared.

The invention we claim is:

1. A system for producing and storing fluid minerals underlying a body of water, comprising:

a. a floating storage structure having
   i. a ship-shaped hull,
   ii. a fluid storage tank in said hull, and
   iii. a swivel assembly positioned along the longitudinal center line and in the forward 20 percent of the length of the structure, the swivel assembly including a stationary core journaled in a vertical well in the floating storage structure;

b. anchoring means secured to said stationary core of said swivel assembly and extending to the floor of the body of water, thereby permitting said floating storage structure to rotate freely through 360° about a substantially vertical axis in response to wind and water forces;

c. a supply flowline extending up through the body of water;

d. a separator unit having an inlet and at least one outlet, said separator unit mounted in said stationary core of said swivel assembly and having said inlet connected to said supply flowline, said separator unit being adapted to separate the fluid flowing through said supply flowline into its liquid and gaseous components and reduced the pressure thereof;

e. a storage flowline having one end in communication with said storage tank; and

f. a swivel means rotatably coupling the other end of said storage flowline with said at least one outline of said separator unit.

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,590,407 Dated July 6, 1971

Inventor(s) Vintila Bratianu and Lewis A. Rupp

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Title page, second column, --Drude Faulconer-- should be included with "Attorneys".

Column 1, line 14, "to wind" should be deleted and --at-- should be inserted;

line 55, "OF" should be --of--;

line 75, "TAlley" should be --Talley--.

Column 3, line 12, "an" should be --and--;

line 24, "raising" should be --rising--;

line 39, "man" should be --main--.

Column 4, Claim 1, line 34, "reduced" should be --reduce--;

line 39, "outline" should be --outlet--.

Signed and sealed this 21st day of December 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patents