April 16, 1968 T. NITESCU 3,377,867

AUTOMATIC SAMPLER

Filed Feb. 24, 1965 3 Sheets-Sheet 1

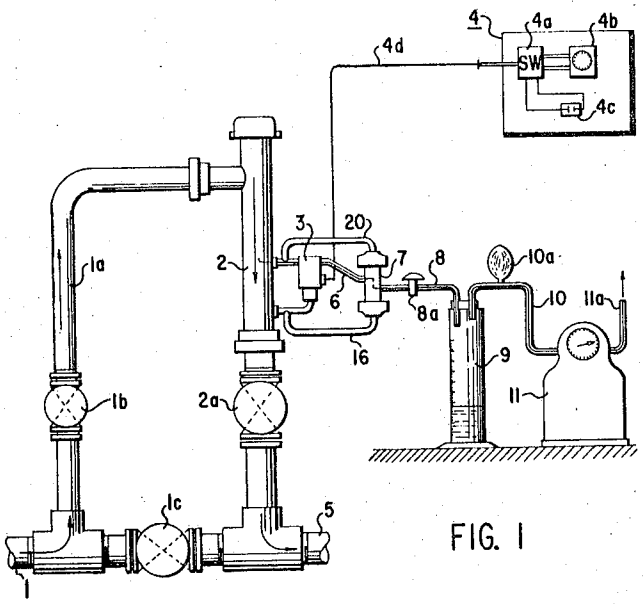


FIG. 1

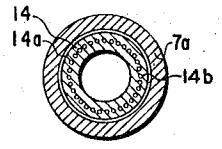


FIG. 3

FIG. 2

Inventor
Trajan Nitescu
By Cushman, Darby & Cushman
Attorneys

April 16, 1968 T. NITESCU 3,377,867

AUTOMATIC SAMPLER

Filed Feb. 24, 1965 3 Sheets-Sheet 2

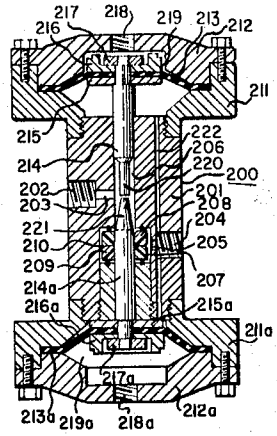


FIG. 4

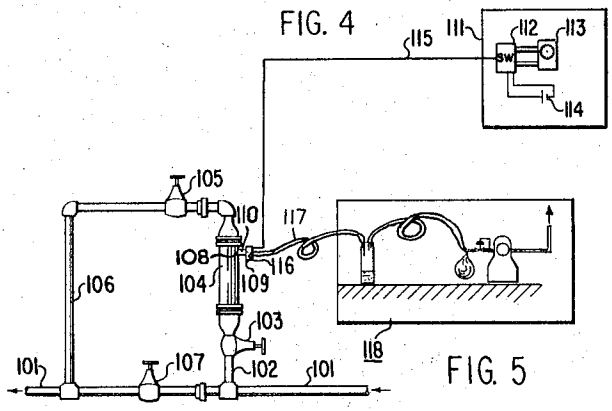


FIG. 5

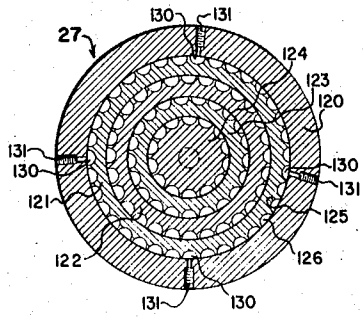


FIG. 6

Inventor
Trajan Nitescu

By Cushman, Darby & Cushman
Attorneys

April 16, 1968 T. NITESCU 3,377,867

AUTOMATIC SAMPLER

Filed Feb. 24, 1965 3 Sheets-Sheet 3

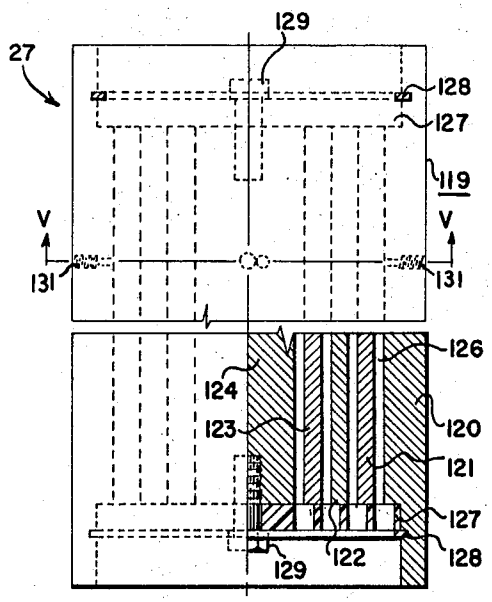


FIG. 7

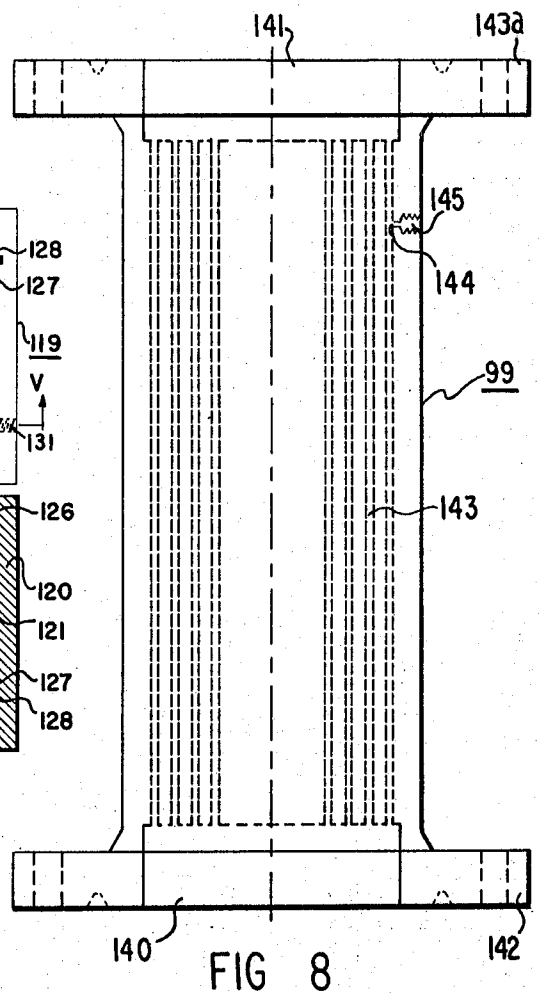


FIG 8

Inventor
Trajan Nitescu
By Cushman, Darby & Cushman
Attorneys

United States Patent Office 3,377,867 Patented Apr. 16, 1968

3,377,867

AUTOMATIC SAMPLER

Trajan Nitescu, 723 Riverdale Ave.,
Calgary, Alberta, Canada

Filed Feb. 24, 1965, Ser. No. 434,882
Claims priority, application Canada, Dec. 15, 1964, 918,810
4 Claims. (Cl. 73—422)

ABSTRACT OF THE DISCLOSURE

An automatic sampling device including a flow divider with a section having a plurality of channels, one of which may be connected to measuring means through a valve actuated by a timer for taking regular periodic samples. The sampling device preferably includes pressure stabilizing means for equalizing the flow within the channels of the flow divider.

This invention relates to an automatic sampling device for a multi-phase non-homogeneous fluid. More particularly it relates to an automatic device for determining the gas-liquid ratio in a multi-phase fluid from producing oil wells.

At present, the oil and associated gas produced from a well is usually directed to a separator where the water, oil and gas are separated, measured independently and then directed to an oil storage center.

It is an object of one aspect of the present invention to determine the gas-liquid ratio of a single producing oil well connected in a gathering system of producing oil wells.

It is an object of another aspect of the present invention to provide an automatic sampling device which will determine the gas-liquid ratios of a composite of periodic samples.

By a broad aspect of the invention there is provided an automatic sampling device for use with a pipe line comprising: a flow divider having inlet means adapted to be connected to said pipe line and outlet means adapted to be connected to said pipe line downstream of the inlet connection, said flow divider consisting of a plurality of channels one of which may be connected to a measuring means by means of a valve; said valve being capable of being actuated by a conventional timing system for the regular periodic sampling of the effluent of said flow channel and a conventional sample measuring means. Preferably, this broad aspect of the invention also includes a pressure stabilizing means for equalizing the flow within the channels of the said flow divider.

By another aspect of the present invention, there is provided a process for determining the liquid-gas ratio of the effluent flowing through a pipe line, comprising: dividing the said effluent into a plurality of substantially identical channels, regularly intermittently sampling the effluent of one of the said channels, preferably by taking, during each sample interval, a volume equal to the volume of said channel and measuring the liquid-gas ratio thereof. Preferably, also, this process includes the step of equalizing the flow pressure throughout all of the said channels.

By yet another aspect, there is provided a fluid pressure regulator for equalizing the pressure on both sides of a bleeder point which comprises: a pressure sensitive diaphragm connected to the upstream end of the said bleeder point, an oppositely activating pressure sensitive diaphragm connected to the downstream end of the said bleeder point and a bleeder channel therebetween; the degree of aperture of the said bleeder channel being related to the pressure differential between the two said diaphragms.

In the accompanying drawings:

FIG. 1 is a side, partially diagrammatic view of one embodiment of the sampler connected to an oil well line;

FIG. 2 is a longitudinal cross-section elevation of the flow divider and zero differential flow controller and a diagrammatic view of the valve means;

FIG. 3 is a plane cross-section of the flow divider along the line III—III of FIG. 2;

FIG. 4 is a central longitudinal sectional view of another embodiment of the zero differential flow controller of the present invention;

FIG. 5 is a side partially diagrammatic view of another embodiment of the present invention;

FIG. 6 is a cross-section of the flow divider used in the embodiment of the present sampler shown in FIG. 7;

FIG. 7 is a central longitudinal section, partly in broken lines, of the channel divider block of FIG. 6; and

FIG. 8 is a central longitudinal section of another channel divider block used in the present invention.

FIG. 1 shows an embodiment of the automatic sampling device in diagrammatic form connected to an oil well line. A by-pass line **1***a* from line **1** from the oil well line (not shown) is connected, via valve **1***b* to a flow divider **2** having a plurality of substantially identical channels. The downstream end of the flow divider is connected via valve **2***a* to outlet flow pipe **5** which may in turn be connected to a common oil gathering system (not shown). A valve means **3** such as a solenoid 3-way valve capable of being actuated by a timing circuit shown at **4** (and including a switch **4***a*, a time controller **4***b* and a battery **4***c* and electrical lines **4***d* leading to solenoid valve **3**) is connected to one of the channels of the flow divider **2**. A bleeder line **6** from valve means **3** is connected to the zero differential flow controller **7**. Line **8** from the outlet end of flow controller **7** is connected, preferably through a back pressure regulator **8***a*, to a graduated cylinder **9** which in turn has a gas outlet **10**, provided with a rubber expansion bag **10***a* connected to a gas meter **11**, which is vented at **11***a*.

The flow divider **2** and zero differential flow controller **7** are shown in detail in FIG. 2. The by-pass line **1***a* leads into the flow divider **2** which comprises a generally cylindrical member **7***d* provided with internal means for divided flow. These means include an orifice plate **12** provided with a central orifice **12***a*, mounted on a screen box **13**, provided with screen apertures **13***a* and secured to a downwardly depending screw **13***b*. Screen box **13** is provided with circumferential O-rings **13***c* to provide sealing connection with the inner walls of cylindrical member **7***d*.

Resting on ledge **2***b* on the inner wall of cylindrical member **7***d* is a channel block **14**. Channel block **14** is provided with a plurality of channels **14***a* which are identical in dimension and set in a substantially circular pattern, as can be seen with reference to FIG. 3. All of channels **14***a* except one are directly connected through header **14***c* to exit line **15** which leads to outlet flow pipe **5** shown in FIG. 1. One channel **14***b* is connected to exit **15** by valve inlet line **21** and valve outlet line **16** through valve means **3**. When valve means **3** is actuated however, valve inlet line **21** is connected to bleeder line **6** shown schematically in FIG. 2, which leads to the zero differential flow controller **7**. Cylindrical member **7***d* is provided with a top cap **2***c*.

The zero differential flow controller **7** shown in FIGS. 1 and 2 consists of a main body **7***a* provided with a longitudinal chamber **7***b* having two identical enlarged opposed end diaphragm chambers **18***a* and **19***a*, provided with diaphragms **18** and **19** respectively. Main body **7***a* is provided with a radial inlet port **25**, provided with a reduced inlet channel **25***a*, and radial outlet port **26** lead-

ing from an outlet channel 26*a*. The outlet port 26*a* (FIG. 2) is connected to the line 8 as indicated by the broken line and the arrow pointing to the numeral 8. Outlet port 3*a* of solenoid valve 3 is connected, via bleeder line 6 to inlet port 25. Diaphragm 18 is connected by pressure line 20 to valve inlet line 21. Diaphragm 19 is similarly connected by pressure line 20*a* to valve outlet line 16. Two metering rods 22 and 23, connected to diaphragms 18 and 19 respectively and provided with reduced diameter tips 22*a* and 22*b* respectively are pressed together in narrow butt-to-butt engagement and are slidably fitted in the longitudinal channel 7*b* by the pressure of their respective diaphragms 18 and 19. The pressure differential between diaphragms 18 and 19 will determine the position of the metering rods within the channel 7*b*. The position which the metering rods so assume determines the size of the flow channel between inlet channel 25*a* and outlet channel 26*a* through longitudinal channel 7*b*, i.e., between bleeder inlet port 25 and outlet port 26.

The operation of the embodiment of the automatic sampling device of FIGS. 1, 2 and 3 will now be described. The output from a typical well is diverted through by-pass line 1*a* by means of opening cut-off valve 1*b* and closing cut-off valve 1*c* and passed through flow divider 2. The pipe line effluent flows through aperture 12*a*, for proper mixing and into screening means 13 for filtration of solid elements. The flow is then divided into a large number of streams by means of channels 14*a*. The oil and gas effluent then continues into exit 15 and then to outlet flow pipe 5. The stream flowing through channel 14*b* normally travels through valve inlet line 21, through valve 3 and out valve outlet line 16 to join the remaining well output at exit 15. When the valve means 3 is actuated however, the effluent of channel 14*b* is diverted from valve inlet line 21 through valve outlet line 3*a* to bleeder line 6 which directs the well sample to the inlet port of zero differential flow controller 7. The sample is then passed through outlet port 26 to a conventional liquid and gas measuring means, such as graduated cylinder 9 and gas meter 11, and is then vented at 11*a*.

The purpose of the zero differential flow controller is to nullify any pressure differential between the valve inlet line 21 and the exit 15. In this way, the flow through channel 14*b* will be identical to the flows of the other channels 14*a*. For example, if the pressure in line 20 and on diaphragm 18 tends to decrease below the pressure in line 22 and on diaphragm 19, the flow channel between inlet port 25 to outlet port 26 will be restricted in size and thus, the flow will decrease. By decreasing this flow, the pressure on diaphragm 18, which is, in fact, the pressure in channel 14*b* is automatically increased, because of the increased back-pressure in line 6. Similarly if the pressure on diaphragh 18 is above the pressure on diaphragm 19, the downward pressure on metering rod 22 will enlarge the passage between inlet port 25 and outlet port 26, thus increasing the rate of flow of the sample and equalizing the flow through channel 14*b* with the flow through all the other channels 14*a*.

To reflect accurately the pressure at the channel 14*b* exit point and the pressures at exit points of the other channels, it is important to have lines 21 and 16 provided with much larger sections than those of channel 14*a* and 14*b*. For sampling effluents under very high pressures, it is preferable to install a back pressure regulator, such as 8*a*, between outlet port 26 and the graduated cylinder 9 where the samples are collected.

With the use of a conventional time controller 4*b*, the automatic sampling device of the present invention can be set either to take a reduced number of minute samples or hundreds of such samples during a twenty-four hour period. The number of samples to be taken depends on the homogeneity of the effluent to be sampled. For an oil producing well, it is preferred to take from 50 to 500 samples per day, each one of a few seconds' duration. The total amount of these collected samples may represent only $\frac{1}{5000}$ of the total effluent sampled. Taking as an example a well producing one hundred barrels per day, it will be necessary during a twenty-four hour period to take a composite sample measuring in the aggregate less than one gallon.

FIG. 4 shows another embodiment of the zero differential flow control of the present invention. The zero differential flow control 200 comprises a main cylindrical body portion 201 provided with a central longitudinal bore 206, a radial inlet port 202 and inlet channel 203 leading to bore 206, and a longitudinally offset radial outlet channel 205 leading from bore 206 to outlet port 204. Bore 206 is provided with an enlarged chamber 207, adjacent outlet channel 205. Within chamber 207 is an upper sealing element 208 and a lower sealing element 209, with a flow channel 210 therebetween.

Secured to the upper portion of body 201 is an upper flange plate 211, to which is secured an upper cover plate 212. Upper cover plate 212 also anchors the peripheral edge of diaphragm 213. Diaphragm 213 is secured to upper rod 214 by means of lower washer 215, upper ring 216 and nut 217. Cover plate 212 is provided with aperture 218 which is adapted to be connected to the pressure line 20 (see FIG. 1). Thus there is provided a pressure chamber 219 on which is acting the pressure on the inlet 218.

A similar arrangement is provided at the lower end of body 201, i.e. lower flange plate 211*a*, lower cover plate 212*a*, diaphragm 213*a*, lower rod 214*a*, washer 215*a*, ring 216*a*, nut 217*a*, inlet 218*a* and pressure chamber 219*a*. Again, the pressure in the chamber 219*a* is equal with the pressure acting through inlet 218*a*, which is adapted to be connected to pressure line 16 (see FIG. 1). Rod 214 is provided with a terminal portion of uniformly reduced diameter 220 while lower rod 214*a* is provided with a terminal portion 221 of conical configuration. Portion 220 abuts portion 221.

As shown in FIG. 4, the pressure acting through inlet 218*a* is greater than the pressure acting through inlet 218. This causes rod 214*a* to be moved upwardly to such an extent that there is no flow of fluid between bore 206 and chamber 207. As the pressure acting through inlet 218 increases rod 214 moves downwardly, thereby permitting fluid to flow from bore 206 to chamber 207. This then allows fluid to flow from inlet 202 to outlet 204. The connecting channel 222 is provided for the equalization of the pressures on the back side of the diaphragms 213 and 213*a*.

It is necessary that the pressure acting through inlets 218 and 218*a* be the same. If the pressure acting through inlet 218 should tend to decrease below the pressure acting through inlet 218*a*, the flow of liquid from inlet 202 to outlet 204 is decreased. Conversely, if the pressure acting through inlet 218 tends to increase above the pressure acting through inlet 218*a*, the flow from inlet 202 to outlet 204 tends to increase.

Another embodiment of the present invention can be seen with reference to FIG. 5.

The inflow from a well (not shown) via line 101 is connected to a by-pass line 102 and through valve 103 to a sampler 104. The effluent from sampler 104 is connected via valve 105 and outlet line 106 to main line 101. Main line 101 is also provided with a cut-off valve 107.

Sample withdrawal port 108 is connected to solenoid valve 109 by a line 110. Solenoid valve 109 is actuated by automatic timing circuit 111, consisting of switch 112, time controller 113 and battery 114, and connected to solenoid valve 109 by electrical lines 115. The outlet port 116 of solenoid valve 109 is connected via line 117 to a conventional sample collecting and measuring equipment 118, which has already been described with reference to FIG. 1 and will not be described again.

The sampler 104 may have an internal construction as shown in FIGS. 2 and 3. Alternatively, the construction

of the channel divider block **99** may be as shown in the embodiments of FIGS. 6 and 7 or the embodiment of FIG. 8. As shown in FIGS. 6 and 7, for example, the channel block **119** of the flow divider **27** consists of a main outer pipe **120** and a plurality of concentric pipes **121, 122, 123** and plug **124**. The pipes **121, 122, 123** and plug **124** are provided with external flutes **125** running longitudinally along the outside of the pipes to provide a plurality of channels **126** between the adjacent pipes. The pipes **121, 122** and **123** and plug **124** are mounted within tube **120** by means of upper and lower perforated plates **127**, whose perforations are in tandem with channels **126**, and a snap ring **128** holding plate **127** in place. Plate **127** is secured to plug **124** by bolt **129**. Turbulence may be created upstream of the flow divider through enlargement in the pipe diameter (as shown in FIG. 4) or by insertion of an orifice screen box and orifice plate, as shown in FIG. 1. Four of the outer channels **130** of the channel divider block **99** are tapped at **131** to provide four alternative withdrawal ports **108**. Only one of such ports **108** is connected to line **110**, the other three being normally plugged. Port **108** is normally closed by valve means **109** except during the sample interval.

An alternative construction of the channel divider block is shown in FIG. 8. Here, the block is provided with an inlet header chamber **140** and an outlet header chamber **141**. The block **99** is provided with a flange **142** to permit it to be connected to an inlet line, and a flange **143***a* to permit it to be connected to an outlet line. The channels **143** are provided in concentric circumferential pattern by drilling channels in the block **99**. One of the external channels **144** is provided with a tapped radial aperture **145** to permit it to be connected to line **110**.

When the automatic timing circuit **111** is actuated, the valve means **109** is opened for a predetermined length of time so that the quantity of flowing effluent admitted to the graduated cylinder is less than the volume of one of the channels **126, 143**. The flow within all the channels of the flow divider is equalized by means of an enlargement of the pipe diameter on each side of the sampler **104**.

With the present invention oil producing wells can now be equipped with a meter installed for continuous measuring of the weight of the total effluent and a sampler of the present invention for determining the gas-liquid ratio of the effluent. By knowing the gas-liquid ratio and the specific gravity of the gas, oil and water components it is possible to calculate the amount of oil, gas and water produced at a certain well. In this manner, a large number of wells may be connected to a single gathering system without requiring an intermediate separating tank. The total effluent can then be directed to a central point where the entire production from the large number of wells can be separated into oil, gas and water components and subsequently used in any desired manner.

I claim:

1. A process for determining the liquid-gas ratio of the effluent flowing through a pipe line, comprising: dividing the said effluent into a plurality of channels, regularly intermittently sampling the effluent of one of the said channels and measuring the liquid-gas ratio thereof; and equalizing the flow volume throughout all of the said channels.

2. A process for determining the liquid-gas ratio of the effluent from well streams which comprises: dividing the effluent from the one individual wellstream into a plurality of channels; equalizing the flow throughout all of the said channels; regularly intermittently sampling the effluent of one of the said channels and measuring the liquid-gas ratio thereof; and connecting effluent from a plurality of such undivided wellstreams to a common gathering system.

3. An automatic sampling device for use with a pipeline comprising: a flow divider having inlet means connected to said pipeline and outlet means connected to said pipeline downstream of the inlet connection, said flow divider including a section consisting of a plurality of channels; a by-pass and return line having an inlet end in one channel of the said flow divider and a return end connected to said flow divider downstream of said section; a valve means in said by-pass line, said valve means being activated for periodic sampling of the effluent of said channel; a differential flow controller connected across said valve means and having two oppositely activated pressure diaphragms, one of which is connected to the inlet end of said channel by-pass line and the other connected to the return end of said by-pass line whereby the flow through said sampling channel may be automatically regulated to be equal to the flow through the other channels of the said flow divider; and a conventional sample measuring means connected through said differential flow controller to said by-pass line.

4. An automatic sampling device for use with a pipeline as claimed in claim **3** wherein said valve means is activated by a conventional timing system for the regular periodic sampling of the effluent of said channel.

References Cited

UNITED STATES PATENTS

371,166	10/1887	Barton	73—203
2,322,018	6/1943	Huber	73—422 X
2,583,177	1/1952	Hoekstra.	
2,736,201	2/1956	Ohlsen et al.	73—422
3,013,431	12/1961	Splettstoeser	73—422
3,241,372	3/1966	Maxwell	73—422

OTHER REFERENCES

Campbell: "How to Sample Separator Fluids," Oil and Gas Journal, vol. 54, Oct. 31, 1955, p. 95.

LOUIS R. PRINCE, *Primary Examiner.*

DAVID SCHONBERG, *Examiner.*

DANIEL M. YASICH, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,377,867 April 16, 1968

Trajan Nitescu

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

Column 3, line 48, "22" should read -- 20a --. Column 5, line 16, "Fig. 4" should read -- Fig. 5 --; line 19, "99" should read -- 119 --; line 38, "143" should read -- 144 --.

Signed and sealed this 11th day of November 1969.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents