United States Patent [19]

Larsonneur

[11] **3,837,199**

[45]*Sept. 24, 1974

[54] **HOT ROLLING MILL LUBRICATION APPARATUS AND PROCESS**

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[73] Assignee: **Nalco Chemical Company,** Chicago, Ill.

[*] Notice: The portion of the term of this patent subsequent to Jan. 9, 1990, has been disclaimed.

[22] Filed: **Nov. 6, 1972**

[21] Appl. No.: **304,103**

[52] **U.S. Cl.** **72/21,** 72/45, 72/201, 72/236

[51] **Int. Cl.**.. **B21b 27/10,** B21b 37/00, B21b 45/02

[58] **Field of Search** 72/41, 43, 44, 45, 200, 72/201, 202, 236, 21

[56] **References Cited**

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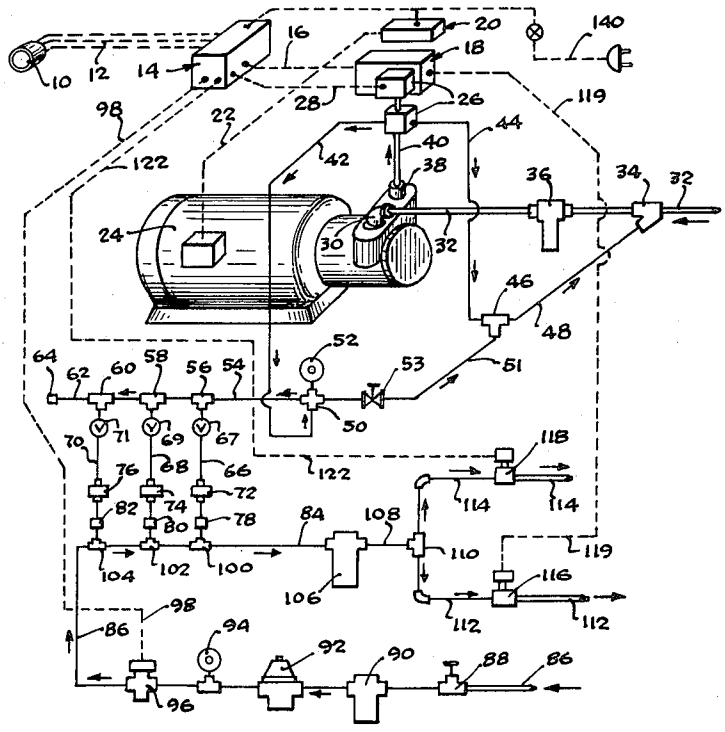
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[57] **ABSTRACT**

A method and apparatus for applying hot rolling mill lubricants composed of water and difficultly dispersible oil to the rolls of rolling stands used to reduce hot steel whereby the lubricant is applied only during the period when the workpiece contacts the rolls of the rolling stands. The oil is continuously circulated in a loop system to maintain it at a desired temperature range, and then admixed with water when a rolling stand calls for lubrication. Water is preferably continuously fed to the rolls for cooling.

2 Claims, 7 Drawing Figures



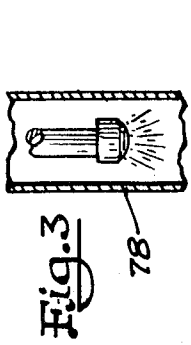


Fig.3

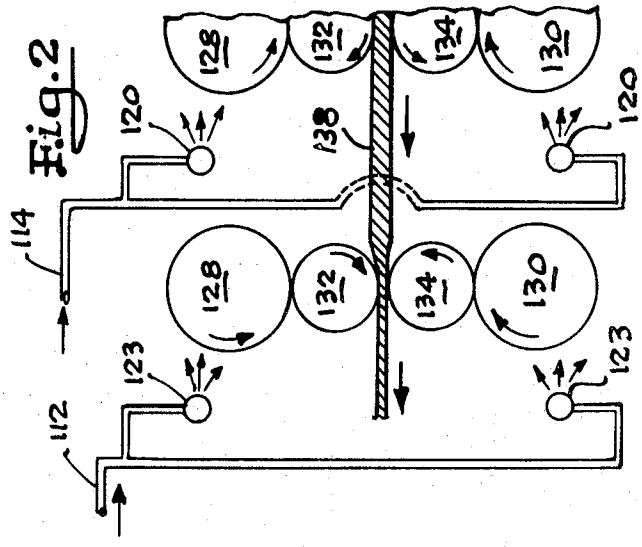


Fig.2

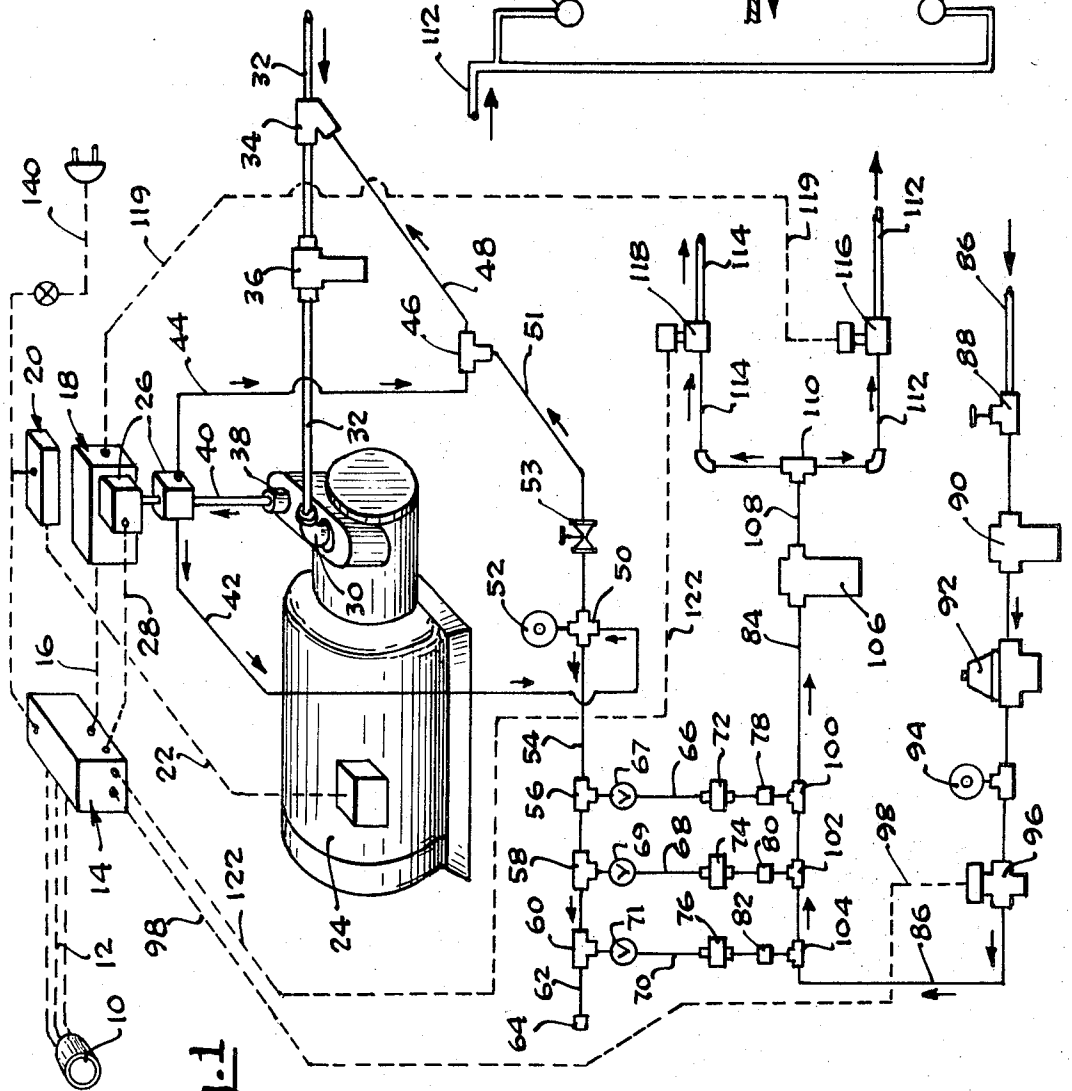


Fig.1

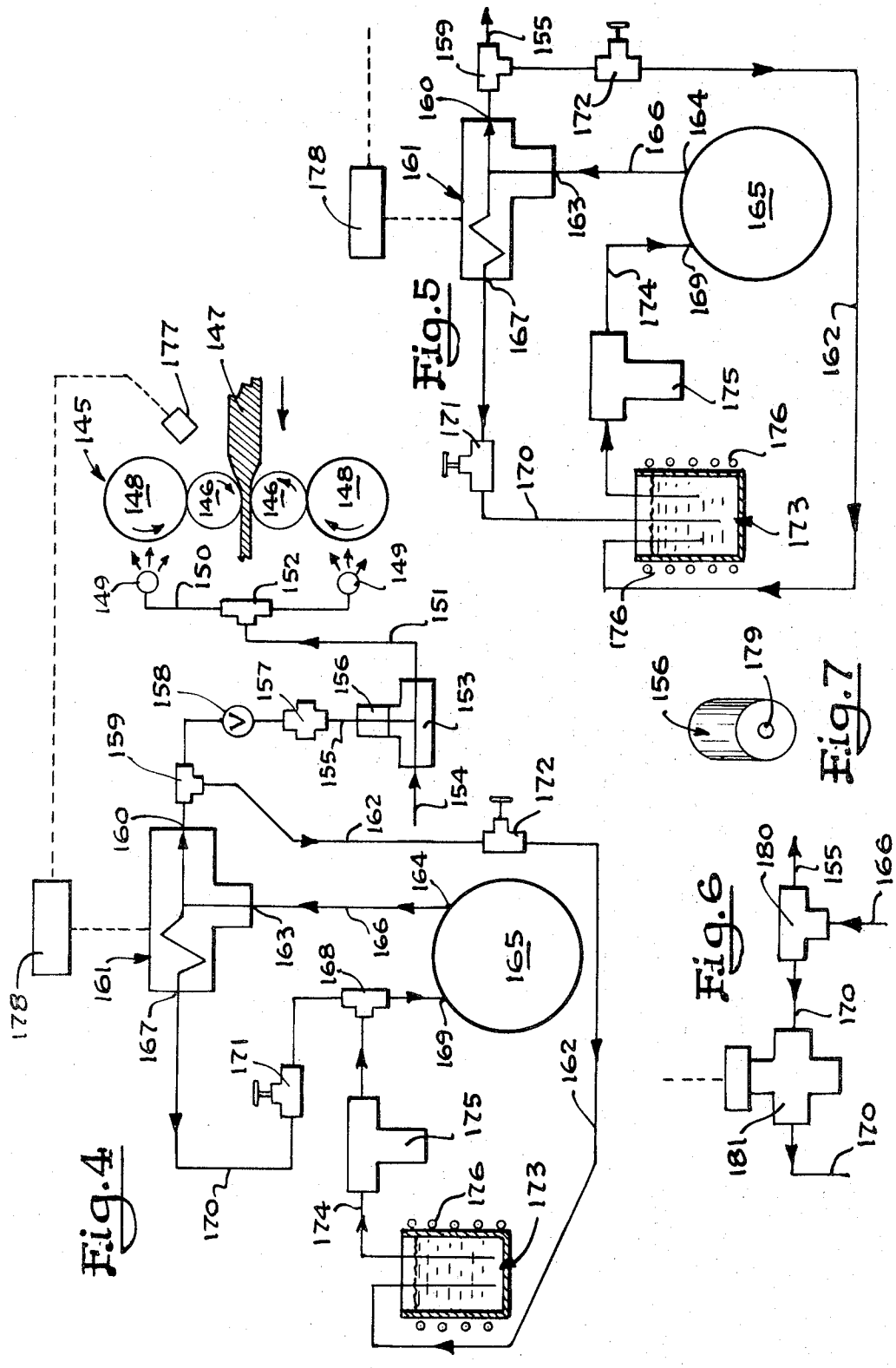


Fig. 4

Fig. 5

Fig. 6

Fig. 7

HOT ROLLING MILL LUBRICATION APPARATUS AND PROCESS

This application is related to my copending application, Ser. No. 103,641, filed Jan. 4, 1971, now U.S. Pat. No. 3,709,012 and to my application, Ser. No. 817,377, filed Apr. 18, 1969.

The invention is directed to a method and apparatus for applying hot rolling mill lubricants, which are composed of water and oil, to the rolls of at least one rolling stand whereby the lubricant is applied during the period when the workpiece contacts the rolls of the rolling stand.

The purpose of using hot rolling mill lubricants is to effectuate a number of the benefits which can only be achieved by the use of lubricants. Effective lubrication during the hot rolling of metals materially increases roll life, thereby reducing the number of roll changes and mill downtime. This results in increased production at lower costs. Proper lubrication minimizes metal pickup from the workpiece and peeling or removal of metal from the rolls to the workpiece as it goes through the various stands of the rolling operation. Most importantly, proper lubrication during the hot rolling of metal gives an improved product surface quality to the improved surface condition of the work rolls. In many instances a reduction of roll grinding requirements is also achieved.

The most desirable type of hot rolling mill lubricants comprise a mixture of a lubricating oil or liquid and water which do not easily form an emulsion, and which preferably form a dispersion. Such lubricants are difficult to apply in hot rolling operations whereby the oil is preferentially coated on the rolls without being washed from the surfaces by the excesses of aqueous cooling fluids used therewith. Greater benefits would be achieved if such water dispersions could be maintained in a state of uniformity during application to the rolls and then break, whereby the oil was preferentially adsorbed on the rolls. Such dispersions would not require the use of emulsifiers, thereby allowing used oil simply to be removed and collected from the mill cooling water effluent without necessitating complicated oil and water separation techniques.

If it were possible to produce dispersions by a simple mechanical means whereby such dispersions when formed would be sufficiently stable that they could be fed directly from such mechanical means to the stand of hot metal rolling mills, a flexibility would be afforded to the metal rolling industry. Such would allow the use of a wide variety of lubricant compositions heretofore unavailable due to the difficulty of forming good dispersions.

Such devices should be of simple construction and be relatively compact to allow transportation and positioning thereof at advantageous points near the rolling mills where they would be used. Also, such devices should possess sufficient flexibility in design and construction whereby the ratio of oil to water used in various hot rolling mill oil dispersions could be varied by simple means so that such variations could be made by unskilled operators who normally attend such equipment.

Another advantage which would be of benefit to the hot metal rolling art would be a device of a type described which would apply lubricant to a metal workpiece contacting the various stands of a hot rolling mill

only at the time that the various rolls of the stand were contacting the workpiece. After the workpiece had been processed by such rolls the supply of lubricant would be discontinued, thereby effectuating a substantial reduction in the quantity of lubricant being used.

The method of the invention includes the steps of continuously circulating oil through a loop system, a part of which would include a heater for cold climates to maintain the oil at a workable temperature, removing from the loop system a quantity of oil in response to a workpiece being in or about to contact a rolling stand, feeding the oil removed from the loop system under pressure to a common lubricant supply conduit, feeding a quantity of water to the common lubricant supply conduit at the desired pressure to mix with the oil. The water is preferably fed continuously to the rolls even when no workpiece is present to effect cooling, while oil is injected into the water on demand of a lubricant. Suitable apparatus is provided to carry out the method.

It is therefore an object of the invention to provide an improved apparatus and method useful for applying water and oil dispersions to the stands used in the hot rolling of various metals.

Another object of the invention is to provide a method for applying hot rolling mill lubricants composed of water and difficultly dispersible oil to the rolls of rolling stands whereby the lubricant is applied only during the period when the workpiece contacts the rolls and is stopped after the workpiece is no longer in contact with such rolls.

Another object is to provide a method for applying lubricant used in the hot rolling of ferrous metals whereby an oil and water dispersion forming a lubricant is provided which dispersion is formed mechanically.

A further object of the invention resides in the provision of a hot rolling mill apparatus for applying a water and oil lubricant on demand in response to the presence of a workpiece wherein the oil is mixed with the water, and where an oil recirculation loop is provided to maintain the oil at a workable temperature.

A still further object of the invention is in the provision of a method and apparatus for applying lubricant to hot rolling mill stands, wherein the lubricant comprises a mixture of water and a difficultly dispersible oil delivered to the rolls through spray headers, and wherein the water is continuously delivered through the headers while the oil is injected in the water during reduction of a workpiece.

Other objects, features and advantages of the invention will be apparent from the following detailed disclosure, taken in conjunction with the accompanying sheets of drawings, wherein like reference numerals refer to like parts, in which:

FIG. 1 is a schematic view of one form of the apparatus used in practicing the invention;

FIG. 2 shows a lubricant formed by the apparatus as shown in FIG. 1 being applied to two stands of a conventional hot strip rolling mill;

FIG. 3 is a cut-away view showing one form of a mixing orifice used to produce an oil and water dispersion;

FIG. 4 is a schematic view of a modified apparatus according to the invention;

FIG. 5 is a schematic view of a further modification;

FIG. 6 is a schematic view of a modified valve arrangement; and

FIG. 7 is a perspective view of a mixing orifice.

With specific reference to the drawings and, in particular, reference to FIG. 1, there is provided a sensing head 10 which is capable of detecting heat generated by a hot workpiece entering a hot rolling operation by means of infrared impulses emanating from such a hot workpiece. Other types of sensing means may be provided, such as a load cell. The sensing head 10 is connected by electrical lines 12 to a control unit 14 which amplifies the signal from the sensing head 10. The amplified signal is delayed to the solenoid valve 116 by the time delay switch 18 which is connected to the control unit 14 through electrical line 16. However, a time delay is optional and not always desired. Also actuated by the amplified signal of control unit 14 is a three-way solenoid valve 26 which is connected to the control unit 14 by means of electrical line 28, and solenoid valves 96 and 118 through electrical lines 98 and 122, respectively. Time delay switch 18 later activates solenoid valve 116 through line 119.

Pump 24 has its suction or input side 30 connected to oil supply line 32 which is connected to an oil supply, such as a storage tank or reservoir, not shown. Oil supply line 32 is fitted with a Y-shaped T 34 and a strainer 36.

The pump discharge port 38 is connected through a line 40 to the inlet port of three-way solenoid valve 26. One outlet port of the three-way solenoid valve 26 is connected to an oil feed supply line 42, and the other outlet port is connected through recirculating line 44 to a T 46, which, in turn, through line 48 connects to the Y-shaped T 34 of oil supply line 32.

It is now evident that lines 40, 44, 48 and 32 define a recirculating loop system whose operation will be more fully explained hereinafter.

Oil passing through oil feed supply line 42 is directed to a four-way T 50 whose top is fitted with a pressure gauge 52. Line 54 which emanates from the left side of four-way T 50 may be considered as an extension of oil feed supply line 42 and is fitted with three connected T's 56, 58 and 60. The left-hand end of T 60 is fitted with a short nipple 62 and a pipe cap 64.

Emanating from the right-hand side of four-way T 50 is line 51 which is fitted with a valve 53 that controls pressure in line 54. Line 51 connects into T 46.

Downwardly extending from the three T's 56, 58 and 60 are lines 66, 68 and 70 which are fitted with on-off valves 67, 69 and 71 respectively, and check valves 72, 74 and 76 respectively. The on-off valves may be manually or power operated, and of any suitable type.

Fitted at the bottom of check valves 67, 69 and 71 are mixing orifices or other mixing devices 78, 80 and 82 that direct oil into a common lubricant supply conduit which is designated generally by the numeral 84. The details of a mixing orifice of one type is shown in FIG. 3.

Also feeding into common lubricant supply conduit 84 is water supply line 86, which is fitted with on-off valve 88, strainer 90 and pressure regulator 92. A pressure gauge 94 and a solenoid valve 96, the latter of which is connected by electrical line 98 to control unit 14, is also fitted in water line 86. It can be seen that water supply line 86 is connected to common lubricant supply conduit 84, which receives oil from T's 100, 102 and 104.

The mechanically mixed oil and water forming the lubricant pass through common lubricant supply conduit 84 and enter a fine mesh strainer 106 and from there through line 108, where the lubricant enters T 110. The feed of lubricant is divided evenly through lines 112 and 114 respectively. Line 112 is fitted with a solenoid valve 116. Similarly, line 114 is fitted with a similar solenoid valve 118. Solenoid valve 116 is connected by means of a suitable electrical conductor 119 to the time delay switch 18, while solenoid valve 118 is connected to the control unit 14 by means of line 122.

As shown to best advantage in FIG. 2, lubricant entering lines 114 and 112 are transmitted to manifold or spray head assemblies 120 and 123 respectively, where lubricant is directed to the surfaces of the top and bottom back-up rolls which are designated by the numerals 128 and 130 respectively. The reduction or work rolls are shown by the numerals 132 and 134 respectively, while the workpiece is designated 138.

A suitable electrical source, is connected to electrical line 140 which connects to pump switch 20 and the control unit 14. In operation, pump switch 20, connected to the pump through electrical line 22, is turned on and the pump starts to run. The sensing head or other sensing device 10 positioned in or near the stand of rolls in a rolling mill is not transmitting a signal or impulse when no workpiece contacts the first stand of the mill. Since the sensing head is not transmitting a signal or impulse to the control unit 14, the three-way solenoid 26 keeps line 42 in a closed position. Therefore, the pump 24 is recirculating oil from line 32 through line 40, through lines 44 and 48 continuously. Check valves 72, 74 and 76 prevent backflow of water should the oil pressure fall below the water pressure. The strainer 36 in line 32 tends to remove fine abrasive particles, such as grit and dirt, which if remained in the oil would tend to score the pump and damage solenoids and mixing orifices or other mixing devices. When a workpiece nears the sensing head sighting position, the control unit 14 actuates the solenoid valve 26 which closes to prevent oil flow through line 44, thereby raising the pressure in line 42 and line 54 above the water pressure to cause injection of oil into the line 84. Simultaneously, the valve 96 opens to allow water flow into line 84, and the valve 118 opens to allow lubricant flow into line 114. The valve 116 opens following timing out of time delay 18 which is triggered from control 14 at the same time valves 26, 96 and 116 are actuated.

The amount of oil that is allowed to flow from T 50 into oil feed supply line 54 is regulated by means of valve 53 which controls the pressure in feed supply line 54. Oil that is not passed through line 54 because of the by-passing action of valve 53 is returned through line 51 by way of T 46 into line 48 to line 32 or to tank and is continuously recirculated through the pump.

Oil passing through line 54 is diverted by means of T's 56, 58 and 60, and is further regulated with respect to its flow by means of on-off control or similar valves 67, 69 and 71. The oil leaving these valves passes through mixing orifices 78, 80 and 82, which are shown to best advantage in FIG. 3, where the oil is sprayed under pressure into T's 100, 102 and 104 and thereby enter common lubricant supply conduit 84 to mix with the water stream.

As oil passes through common lubricant supply conduit 84, water at a regulated pressure, if necessary, is

also passing into this same line through line **86** which is connected to line **84.** Water supply line **86** is fitted with an on-off valve **88,** and optionally a strainer **90** which acts to remove foreign particles from the water. To insure uniformity of pressure within the common lubricant supply conduit, water supply line **86** is fitted with pressure-regulating valve **92,** which allows water at a substantially constant pressure to enter line **84.** Line **86** is fitted with solenoid valve **96,** which is actuated in response to the energizing of sensing head **10** through means of control unit **14.**

When water passing through water supply line **86** enters common lubricant supply conduit **84,** it contacts the oil sprays produced by mixing orifices **78, 80** and **82** where a thorough and intimate mixture of the oil occurs by forming a relatively short-lived yet stable dispersion.

As the oil dispersed in line **84** contacts strainer **106,** which contains finely-spaced filter media (e.g. **50** mesh or less, most typically **100** mesh) it is further filtered where it is then fed through T **110** into lubricant feed lines **114** and **112.** The strainer **106** is optional and needed only when the openings in the spray headers might be clogged by particles that may pass through the initial strainers in the oil and water line. Time delays are only used where necessary and are applicable to stands receiving the workpiece from the first stand, and even where plural stands are employed time delays may not be needed. As the lubricant leaves lines **114** and **112,** it is transmitted to spray heads **120** and **123,** where it contacts the delivery side of the top and bottom back-up rolls **128** and **130,** which thereby supplies lubricant to all the rolls and the workpiece **138.**

As the workpiece passes beyond the sensitivity limitations of the sensing head **10,** the sensing head deenergizes by means of the control unit **14** the solenoid valves **96, 116** and **118** which are returned to the closed position. Actuation of the three-way solenoid **26** in response to the deenergizing of sensing head **10** opens recirculating line **44** to drop the pressure in lines **42** and **54,** and oil recirculates throughout the recirculating loop previously described.

It is understood that the time delay switches are set to correspond to the normal speed of the workpiece through the rolling stands. Thus, when the infrared sensing head energizes the control unit, the lubricant will be applied to the rolls of each stand just as the workpiece enters it and for a period of time sufficient to allow the workpiece to pass therethrough.

It will be further understood that numerous variations and adaptations of the invention may be made by those skilled in the art without departing from the spirit thereof.

In actual mill practice, the apparatus of the invention will be so constructed to supply lubricant to several of the stands used in a metal reduction operation. Thus, for example, good results may be achieved if spray illustrated by numerals **120** and **123** are placed at, for instance, the second, third, and last stands. The number of rolls treated and the sides treated can, of course, be varied infinitely by increasing the number of lines corresponding to lubricant supply lines **112** and **114,** respectively.

The pressure regulating valve, solenoid valves, and the like, allow control of pressure and feed of the oil and water components of the finished lubricant. Typical of the dispersions that can be produced are dispersions which contain from 0.001–50 percent of a lubricating oil with the balance being water. In actual use, it has been found that the invention allows the elimination of substantially all of the emulsifiers normally used to prepare a hot mill rolling emulsion-type lubricant, and yet the dispersed lubricant applied by the device is completely uniform and stable through application. It allows excellent lubrication to be afforded.

While the apparatus and methods described are directed to producing uniform dispersions of oil and water for use in the hot rolling of metal, it is understood these same techniques and apparatus may be used for some stable emulsions of oil and water in the presence of emulsifying agents.

From the foregoing, it will be understood that the apparatus disclosed in FIGS. **1–3** operates to apply a lubricant composed of water and oil to the roll stands upon demand when a workpiece is moving through the roll stands, and when no workpiece is moving through the roll stands, the lubricant is discontinued. A variation and preferred arrangement is illustrated in FIG. **4,** wherein water is continually supplied to the spray headers adjacent the roll stands and oil is injected into the water to form a lubricant upon demand during the presence of a workpiece. Thus, the rolls in a stand are being cooled by the continuous application of water thereto in the absence of a workpiece from the same spray headers that produce the lubricant when needed. As in the embodiment of FIGS. **1–3,** the lubricant comprises a dispersion of oil and water wherein the oil is mechanically mixed with the water by being injected into the water with a suitable mixing device.

Referring to FIG. **4,** the apparatus there illustrated for applying cooling water and lubricant to a roll stand **145** operates to apply the lubricant during the presence of a workpiece and to apply cooling water during the absence of a workpiece. Roll stand **145** includes work or reducing rolls **146** defining a bite through which a workpiece **147** moves, and back-up rolls **148.** This roll stand is only exemplary of one type of roll stand to which the present invention may apply, and it is understood that the present invention may be used in conjunction with any type of roll stand, whether it have two, three or four rolls, and to a plurality of roll stands arranged in a group, if that be desired. Spray headers **149** apply the cooling water or lubricant to the delivery side of the back-up rolls **148.** It should be recognized that the spray headers may be arranged to apply the lubricant and/or cooling water directly to the work rolls if desired, and in that case such could be applied at the entry side.

A common line **150** connecting to the spray headers **149** is connected to a cooling water and/or lubricant line **151** through a T **152,** so that whatever is passing through the line **151** is substantially equally distributed between the spray headers **149.** The line **151** is connected to a T **153** which is connected to a water supply line **154** and an oil injection line **155.** The water supply line **154** continually supplies water to the line **151** at a relatively constant pressure, and when the oil pressure in line **155** exceeds that of the water pressure, oil is injected into the water to form the lubricant dispersion which is then delivered to the spray headers **149.** A mixing device **156** in the form of a mixing orifice eductor, or other suitable structure, functions to mix the oil into the water at the T **153** when the oil pressure in line **155** exceeds that of the water pressure in line **154.**

In order to prevent back flow of water into the oil line **155**, a check valve **157** is provided. A conventional on-off valve **158** is provided in line **155** ahead of the check valve **157**.

The oil injection line **155** is connected through a T **159** to port **160** of a three-way solenoid valve **161**, and to a recirculating pressure control line **162**. The solenoid valve **161** includes an inlet port **163** connected to the discharge **164** of pump **165** by a line **166**. A second outlet port **167** of the solenoid valve **161** is connected through a T **168** to the suction **169** of the pump **165** through a recirculating line **170**. A pressure regulating valve **171** is provided in the line **170** to maintain maximum oil flow through return line **162** without injection of oil into the water stream when the solenoid valve **161** is open to allow oil flow through both outlet ports **160** and **167**.

A pressure regulating valve **172** is provided in the return line **162** and is set to cause the oil pressure in line **155** to exceed that of the water pressure to cause injection of oil into the water stream when the solenoid valve **161** is closed and oil discharge is only permitted through outlet port **160**. The return line **162**, since the valve **172** is always at least cracked, recirculates oil into the oil storage tank or reservoir **173**. Oil is drawn from the tank **173** through line **174** to the suction side of the pump through T **168**. A strainer **175** is provided in the line **174** to filter out particles that would impede operational oil flow and/or damage elements in the circuit.

During normal operation of the roll stand **145**, in the absence of a workpiece, water is supplied to the spray header **149** to effect a cooling action on the rolls. The pump **165** would be continually running and would be recirculating oil through recirculating line **170** and return line **162**. A heater **176** maintains a substantially constant temperature of the oil in the tank **173**, and recirculation maintains the oil in the lines at a working temperature. During this stage of operation, the solenoid valve **161** is open to allow discharge from both outlet ports **160** and **167**. Upon the detection of a workpiece at or near the roll stand **145** by the detector **177**, a signal is transmitted to a control unit **178** operating the solenoid valve **161** to close off the outlet port **167** thereby increasing the oil pressure in injection line **155** above the pressure of water in the water line **154** to cause injection of oil into the water and the formation of a lubricant dispersion for application to the rolls. The water in the lubricant dispersion cools the rolls, while the oil lubricates. Thereafter, when the detector no longer sees the presence of a workpiece, the signal will be removed from the control unit **178** to allow the solenoid valve **161** to open so that oil will be discharged from both outlet ports of the valve thereby decreasing the pressure in the injection line **155** below that of the water pressure and ceasing injection of oil into the water. Only water will then be discharged from the spray headers **149** to effect a continuing cooling action on the rolls. When the solenoid valve **161** is opened, oil is recirculated through the line **170** and the return line **172**, and upon closure of the valve **161**, oil is recirculated only through return line **162**. Accordingly, the temperature of the oil will be maintained at a working level by the recirculation. Further, oil will be injected into the water stream to form a lubricant only when a lubricant is needed during the presence of a workpiece at the roll stand.

It will be recognized that any number of spray headers may be provided for one or more roll stands depending upon the installation, and selective oil injection into the water stream for any one roll stand may be accomplished by suitable instrumentation and controls. While any type of mixing device **156** may be provided, one form is shown in FIG. **7**, which is of the mixing orifice type, wherein an orifice **179** is provided through which the oil is forced under pressure from the oil injection line into the water stream of the common line for mechanical mixing therewith. Depending upon the installation, pressure in the oil injection line and the size of the orifice **179** will be coordinated to define the proper mixing operation.

The solenoid valve **161** may be defined as a three-way valve in that it includes one inlet port and may be conditioned to discharge through one or both of the outlet ports, but it should be understood that any suitable valve arrangement may be provided to accomplish the split and/or single stream flow. To illustrate another form, reference is made to FIG. **6**, wherein like reference numerals are applied to like elements for purposes of clarity, it being here shown that the pump discharge line **166** is connected to a T **180**, which in turn splits the stream to oil injection line **155** and recirculating line **170**. A simple on-off two-way solenoid valve **181** is provided in the recirculating line **170** to stop or allow oil flow through the recirculating line and control oil pressure in the oil injection line **155**.

The embodiment of FIG. **5** differs from the embodiment of FIG. **4** only in that the recirculating line **170** is connected directly to the oil tank **173**, this arrangement providing better circulation through the heated body of oil in the tank **173**. Otherwise, the arrangement of this embodiment operates in the same fashion as that of FIG. **4**.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention, but it is understood that this application is to be limited only by the scope of the appended claims.

This invention is hereby claimed as follows:

1. Apparatus for applying a hot rolling mill lubricant of water and a difficultly dispersible oil to a roll stand during the presence of a workpiece in the stand, said apparatus comprising spray header means at the roll stand from which the lubricant is discharged onto the roll stand during the presence of a workpiece, a common line connected to said spray header means, a pressurized water supply connected to said common line to provide water thereto at a given pressure range, means for injecting oil into the common line to mix with the water and form a lubricant dispersion, said injection means including an oil injection line connected to the common line, a pump having a suction port and a discharge port, an oil supply connected to the suction port, an oil recirculating line connected on one side to said supply, a discharge line connected from the pump discharge port to the other side of the oil recirculating line and to the oil injection line, and valve means between the discharge line and the oil injection line for selectively opening and closing communication between the discharge line and the oil injection line to cause injection of oil into the water and form the lubricant.

2. Apparatus as defined in claim **1**, which further includes means detecting the presence and absence of a workpiece at the roll stand for controlling said valve means to cause injection of oil into the common line during the presence of a workpiece.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,837,199 Dated September 24, 1974

Inventor(s) Louis C. Larsonneur

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

Col. 1, line 11, after "applied" insert --only--; and
line 25, after "quality" insert --due--.

Signed and sealed this 28th day of January 1975

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.