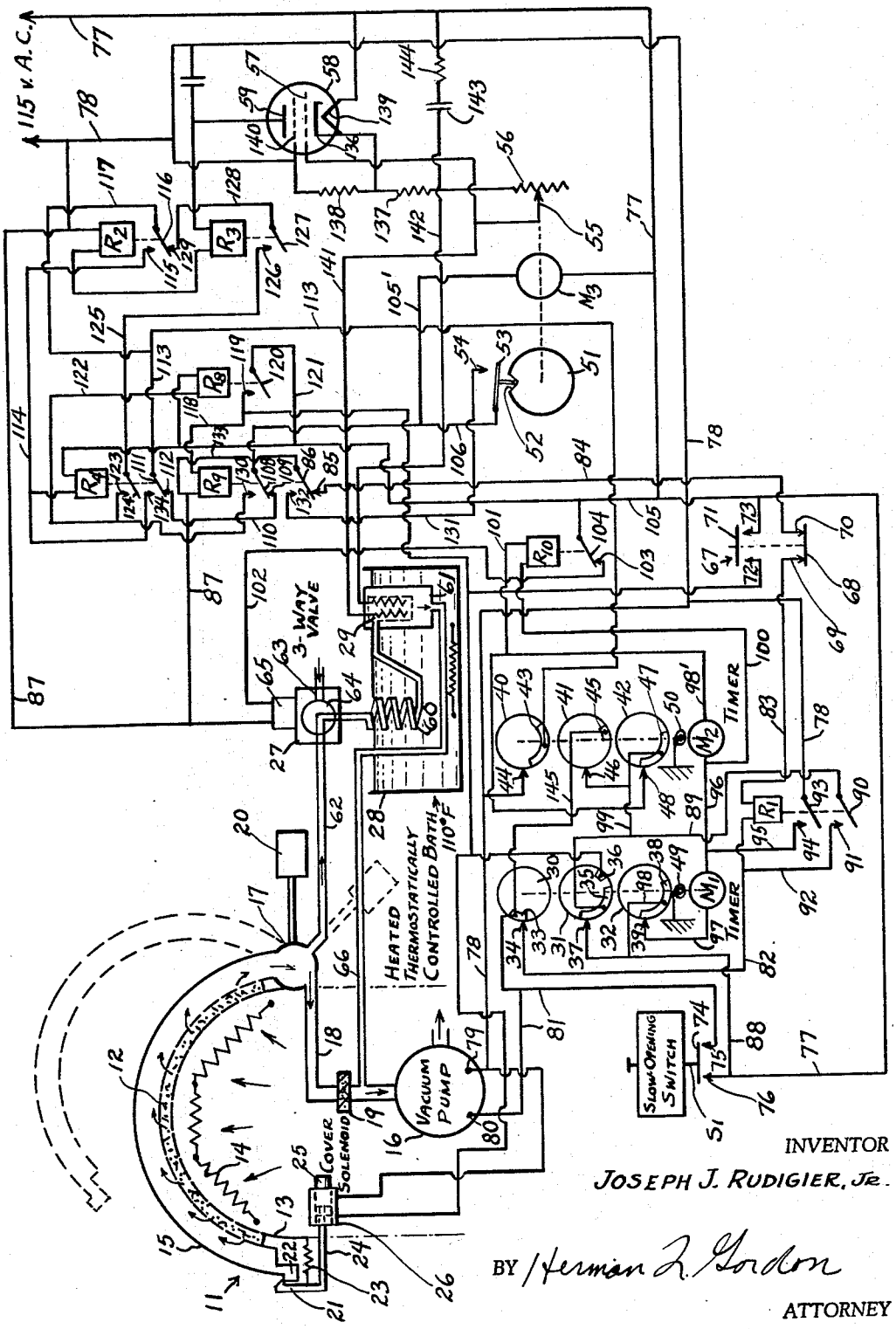
Oct. 18, 1966 J. J. RUDIGIER, JR 3,279,089

MAT DRYER HUMIDITY CONTROL SYSTEM

Filed July 1, 1963



INVENTOR

JOSEPH J. RUDIGIER, JR.

BY Herman L. Gordon

ATTORNEY

United States Patent Office 3,279,089 Patented Oct. 18, 1966

3,279,089

MAT DRYER HUMIDITY CONTROL SYSTEM

Joseph J. Rudigier, Jr., Bethesda, Md., assignor to Hygrodynamics, Inc., Silver Spring, Md.

Filed July 1, 1963, Ser. No. 291,712
5 Claims. (Cl. 34—45)

This invention relates to drying apparatus, and more particularly to apparatus for controlling the moisture content in mats which are used to cast type in a roto-gravure press for printing newspapers and for other high speed printing applications.

A main object of the invention is to provide a novel and improved apparatus for controlling the moisture content in a mat dried over a curved platen which has holes through it communicating with a vacuum system, the apparatus involving relatively simple components, being reliable in operation, and providing close control of the humidity of the mat, so that the drying cycle will terminate automatically when the humidity in the mat has decreased to a predetermined desired value.

A further object of the invention is to provide an improved humidity control apparatus for a mat dryer, the apparatus requiring inexpensive components, being relatively compact in size, and providing automatic and efficient control of the drying cycle of the mat dryer, and taking into account the humidity in the room containing the mat dryer.

A still further object of the invention is to provide an improved control apparatus for a mat dryer employed to form and dry mats used to cast type for high speed printing operations, the control apparatus being arranged to govern the operating cycle of a vacuum pump used in conjunction with heating means to shape and dry the mats, as well as to automatically open the dryer for removal of the mats when the drying cycle of the mats has been completed.

Further objects and advantages of the invention will become apparent from the following description and claims, and from the accompanying drawing, wherein the single figure is a wiring diagram showing the electrical connections of an improved humidity control system for a mat dryer in accordance with the present invention.

Referring to the drawing, **11** generally designates a machine for drying a mat **12** used to cast type in a roto-gravure press for printing newspapers or for similar high speed printing applications. The machine **11** is of conventional mechanical construction and includes an apertured curved platen, shown diagrammatically at **13**, through which air, heated by heating coils **14**, is drawn through the perforated concave bottom wall of a hollow hinged cover **15** by means of a vacuum pump **16**. As shown, the hinged cover **15** has a rotatable air connection joint, indicated diagrammatically at **17**, communicating with a conduit **18** provided with a filter unit **19**, said conduit **18** leading to the inlet port of the vacuum pump **16**. The cover **15** is provided with a counterweight **20** which biases the cover toward an open position, as is shown in dotted view, the cover being held in its closed position by a latch **21** engageable over a projection **22** on the free edge of the cover, the latch being biased toward locking position by a spring **23**. The stem **24** of the latch is secured to the plunger **25** of a solenoid **26**, which when energized moves the latch outwardly to disengage it from projection **22** and to thereby release the cover.

To dry the mat **12** it is first placed against the concave inner side of the cover **15**, after which the cover is closed to the position shown in full line view in the figure, whereby heated air may be drawn through the mat by the vacuum pump **16**. As will be presently described, the drying cycle will terminate automatically when the humidity in the mat has decreased to a predetermined desired value.

The control system for the mat dryer includes a start switch S_1 of the slow-opening type, which, after being manually closed, opens after a predetermined time period, for example, 15 seconds. The system further includes a relay R_1, motor-operated timers M_1, M_2 and M_3, further relays R_2, R_3, R_4, R_8 and R_9, a three-way solenoid-operated air valve **27**, and a thermostatically controlled heated bath unit **28** containing a bifilar-wound humidity sensing unit **29**, all of which will be presently described in detail.

Timer M_1 has the three driven rotor elements **30**, **31** and **32**. Rotor element **30** carries a peripheral contact **33** engageable by a fixed contact **34**. Rotor element **31** has spaced peripheral contacts **35** and **36** sequentially engageable by a fixed contact **37**. Rotor element **36** has a peripheral contact **38** engageable by a fixed contact **39**.

Timer M_2 has the three driven rotor elements **40**, **41** and **42**. Rotor element **40** carries the peripheral contact **43** engageable by a fixed contact **44**. Rotor element **41** carries the peripheral contact **45** engageable by a fixed contact **46**. Rotor element **42** carries a peripheral contact **47** engageable by a fixed contact **48**. The rotors of the timers M_1 and M_2 are biased toward the starting positions shown in the figure by suitable spring means, such as the spiral biasing springs **49** and **50** diagrammatically illustrated.

Timer M_3 drives a cam disc **51** having a peripheral notch **52**. Said disc is engaged by a follower lug on a pivoted switch pole **53** engageable with a fixed contact **54** except when said follower lug engages in the notch **52**, which is the normal starting position. Timer M_3 also drives the adjustable contact **55** of a rheostat **56**. Said rheostat is connected in a manner to regulate the bias potential on the control grid **57** of a vacuum tube **58** in a circuit similar to that disclosed in U.S. Patent No. 2,943,245, to C. E. Ohlheiser, entitled "Humidity Control Device." The relays R_2 and R_3 are connected in circuit with the plate **59** of said tube, said relays having different sensitivities. The humidity sensing element **29** is connected in circuit with said grid **57** in a manner to cause the plate current of tube **58** to drop with increasing humidity, and conversely, to cause said plate current to increase with decreasing humidity. When the plate current increases, relay R_3 closes first, and relay R_2 closes subsequently, with continued increase in plate current. Similarly, when the humidity increases, relay R_3 becomes deenergized first, followed subsequently by the deenergization of relay R_2 as the humidity continues to increase.

The bath **28** contains a tempering coil **60** connected at one end to the upper portion of a chamber **61** containing the humidity sensing element **29**. The other end of said coil **60** is connected through the three-way valve **27** to a conduit **62** leading to the air space **17**. Three-way valve **27** has a port **63** exposed to atmosphere. The valve rotor **64**, in the deenergized condition of solenoid **65**, connects coil **60** to atmosphere port **63**. When the solenoid **65** of the valve is energized, rotor **64** is turned so as to connect coil **60** to the conduit **62**.

The lower end of chamber **61** is connected by a conduit **66** to conduit **18** adjacent pump **16**.

Bath **28** is provided with suitable thermostatically controlled heating means to maintain a predetermined liquid temperature therein for example, 110° F.

A manually controlled two pole switch **67** is provided, said switch having a lower movable pole **68** normally engaging a pair of contacts **69** and **70**, and having an upper movable pole **71**, ganged with pole **68**, and movable into engagement with a pair of contacts **72**, **73** as pole **68** disengages from contacts **69**, **70**.

Slow-opening manual switch S_1 has the movable pole **74** which is engageable with the fixed contacts **75, 76**. A first supply conductor **77** is connected to contact **76**. A second supply conductor **78** is connected to one terminal **79** of vacuum pump **16**. The other terminal **80** of said vacuum pump is connected by a wire **81** to switch contact **75**. Thus, when switch S_1 is closed, pump **16** becomes energized through a circuit comprising line wire **77**, contact **76**, pole **74**, contact **75**, wire **81**, the pump motor winding, and line wire **78**. Relay R_1 also becomes energized through a circuit comprising line wire **77**, contact **76**, pole **74**, contact **75**, timer contacts **33** and **34**, a wire **82**, the winding of relay R_1, a wire **83**, switch contacts **69, 70** and pole **68**, a wire **84**, lower contact **85** and lower pole **86** of relay R_9, wires **133** and **87**, and the line wire **78**.

Relay R_1 has a holding circuit shunting the series arrangement of contacts **33, 34** and switch S_1, comprising a wire **88** connected to line wire **77**, timer contacts **37, 35**, a wire **89**, the lower pole **90** and associated contact **91** of the relay R_1, and a wire **92**.

The energization of relay R_1 will energize motor timers M_1 and M_2. Timer M_1 is energized through a circuit comprising line wire **78**, the upper pole **93** of relay R_1 and its associated contact **94**, a wire **95**, a wire **96**, motor timer M_1, a wire **97**, timer contacts **39, 38**, a wire **98**, wire **88**, and line wire **77**. Timer M_2 is energized by a circuit including wire **96**, motor timer M_2, a wire **98'**, timer contacts **48, 47**, a wire **99**, wire **89**, timer contacts **35, 37**, wire **88**, and line wire **77**.

Relay R_{10}, connected in parallel with timer M_2 by wires **100** and **101**, likewise becomes energized.

The three-way valve solenoid **65** has an energizing circuit comprising line wire **78**, wire **87**, solenoid **65**, a wire **102**, contact **103** and pole **104** of relay R_{10}, a wire **105**, and line wire **77**.

Motor timer M_3 may be energized from a circuit comprising line wire **77**, motor timer M_3, a wire **105'**, a wire **106**, upper pole **108** and associated lower contact **109** of relay R_9, a wire **110**, lower pole **111** and associated lower contact **112** of relay R_4, a wire **113**, timer contacts **43, 44**, and line wire **78**.

Relay R_4 may be energized by a circuit including line wire **77**, wire **105**, the winding of relay R_4, a wire **114**, upper contact **115** and pole **116** of relay R_2, a wire **117**, wire **113**, timer contacts **43, 44**, and wire **78**.

Relay R_9 may be energized by a circuit comprising line wire **78**, wire **87**, the winding of relay R_9, a wire **118**, the contact **119** and pole **120** of relay R_8, a wire **121**, wire **105**, and line wire **77**.

Relay R_8 may be energized by a circuit including line wire **77**, wire **105**, the winding of relay R_8, a wire **122**, and a first branch circuit comprising upper contact **123** and pole **124** of relay R_4, a wire **125**, contact **126** and pole **127** of relay R_3, a wire **128**, lower contact **129** and pole **116** of relay R_2, wire **117**, wire **113**, timer contacts **43, 44**, and line wire **78**, or a second branch circuit comprising upper contact **130** of relay R_9, pole **108**, wire **106**, timer switch pole **53** and associated contact **54**, a wire **131**, contact **132** and pole **86** of relay R_9, a wire **133**, wire **87**, and line wire **78**.

Relay R_4 has a holding circuit shunting upper contact **115** and pole **116** of relay R_2, comprising wire **114**, contact **134** and pole **111** of relay R_4, wire **113** and wire **117**.

As above mentioned, the vacuum tube **58** is connected in a convention circuit, disclosed and described in detail in U.S. Patent No. 2,943,245. In this circuit alternating current supply line wire **78** is connected to the cathode **136** through resistor **138**, the tube filament **139** being connected between cathode **136** and line wire **77**. Screen **140** is connected to line wire **78**. Control grid **57** is connected to cathode **136** through the rheostat **56** and resistor **137**. One terminal of the humidity sensing element **29** is connected by a wire **141** to the control grid **57** and the sliding tap **55**, and the other terminal of sensing element **29** is connected by a wire **142** to the line wire **77** through a condenser **143** and a resistor **144**. As explained in the above mentioned Patent No. 2,943,245, a negative signal in phase with the rectified current (in the plate circuit of the tube) is applied to grid **57**, said signal varying in magnitude with humidity, and the magnitude of the rectified current varies substantially inversely with humidity.

The step-by-step operation of the apparatus shown in the figure is as follows:

(1) The damp mat is placed against the perforated inner face of the open cover **15**.

(2) Start switch S_1 is closed by depressing its operating button. This energizes the vacuum pump **16**, and the mat **12** is held against the perforated inner face of the cover by the vacuum created inside the cover.

(3) The operator then closes the cover **15**, which is held closed by the spring-loaded latch **21**.

(4) The closure of switch S_1 also energizes the interlock relay R_1 through contacts **33** and **34** of timer M_1. Relay R_1 energizes relay R_{10} and timers M_1 and M_2. Relay R_1 is held closed by its contacts **90, 91** and will not release until the completion of the drying cycle (the energization of relay R_9 and the opening of its contacts **85, 86**). Contacts **33, 34** of timer M_1 open shortly after the energization of said timer M_1. Contacts **103, 104** of relay R_{10} open, deenergizing solenoid **65**.

(5) Air from the room is drawn through the three-way valve **27** into the tempering coil **60** in bath **28**, where it is raised in temperature and passes through the humidity sensing chamber **61** and through conduit **66** into the vacuum pump. The sensing chamber **61** is thereby conditioned during the first few seconds to the room humidity, raised to 110° F.

(6) As soon as timer M_2 is energized, contacts **44** and **43** are closed, which energizes timer M_3 through contacts **111, 112** of relay R_4. Timer M_3 closes contacts **53, 54** and also drives sliding rheostat contact **55** in a direction which causes the plate current in the tube **58** to rise. When said plate current reaches the pull-in value of relay R_2, said relay is energized, closing contacts **115, 116**, and relay R_4 becomes energized through said contacts **115, 116**. Relay R_4 is held energized by contacts **134, 111**. The plate current in tube **58** is determined by the ratio of the resistance of rheostat **56** to the resistance of the humidity sensing element **29**.

(7) When relay R_4 pulls in, timer M_3 is deenergized because contacts **111, 112** are opened. Movement of contact **55** therefor stops and maintains a setting of rheostat **56** proportional to the room humidity as sensed by the sensing element **29**. This operation is completed in approximately the first **10** seconds after switch S_1 is closed.

(8) Switch S_1 opens approximately 15 seconds after the initial closure thereof. When said switch opens, vacuum pump **16** becomes deenergized.

(9) After a preset time interval (of the order of between 1 and 2 minutes) contacts **45** and **46** of timer M_2 close, which reenergizes the vacuum pump through a circuit comprising line wire **77**, wire **88**, contacts **37, 35** of timer M_1, wire **89**, wire **99**, contacts **45, 46** of timer M_2, a wire **145**, wire **81**, vacuum pump **16**, and line wire **78**. Again room air is drawn into the tempering coil **60**.

(10) Timer contact **47** is of sufficient peripheral length to delay the opening of contacts **48, 47** for approximately **9** seconds after contacts **45, 46** close. When contacts **48, 47** open, timer M_2 and relay R_{10} become deenergized. Relay contacts **103, 104** close and solenoid **65** becomes energized, causing valve rotor **64** to turn so as to connect coil **60** to conduit **62**.

(11) Moist hot air from the dryer cover **15** is then drawn into the coil **60** and brought to a temperature of 110° F. The sensing element **29** responds to this high humidity and causes the plate current of tube **58** to drop, which deenergizes relay R_2.

(12) As the drying process continues, the air in cover **15** becomes less humid. This is detected by the sensing

element **29**, and when the humidity in the cover air decreases to a value which is about 2% above the room air relative humidity, the accompanying increase in plate current of tube **58** causes sensitive relay R_3 to pull in, energizing relay R_8 through contacts **126**, **127**.

(13) Relay R_9 and cover latch release solenoid **26** are energized through contacts **119**, **120** of relay R_8. The cover solenoid causes plunger **25** to move toward the left, as viewed in the figure, causing latch **21** to disengage from projection **22**, releasing the cover, which swings open to the dotted view position thereof, due to the action of counterweight **20**.

(14) When relay R_9 is energized, contacts **85**, **86** open, causing relay R_1 to become deenergized, and energizing timer M_3 through contacts **86** and **132** of relay R_9 and contacts **53** and **54**.

(15) When relay R_1 becomes deenergized, timers M_1 and M_2, and relay R_{10} become deenergized by the opening of contacts **94**, **93**. Timer contacts **45**, **46** open, deenergizing the vacuum pump **16**. Timer contacts **43**, **44** also open, deenergizing relay R_4.

(16) Relay R_8 is held energized through wires **78**, **87** and **133**, and contacts **86**, **132**, **54**, **53**, **108** and **130**. Relay R_9 is held energized through contacts **120** and **119** of relay R_8.

(17) When timer M_3 returns to its starting position, the follower lug on pole **53** enters notch **52**, opening contacts **53**, **54**, and deenergizing said timer M_3 and Relay R_8. When relay R_8 drops out, relay R_9 is thereby deenergized. This completes the drying cycle.

The manually controlled switch **67** may be employed to override the automatic humidity control means at any time, as desired. It will be seen that relay R_1 can be deenergized by operating this switch to cause lower pole **68** to disengage from contacts **69**, **70**. Also, the engagement of upper pole **71** with contacts **72**, **73** causes latch release solenoid **26** to become energized.

The structure above described and illustrated in the drawing defines a differential system which stops the drying cycle when the cover air humidity drops to a value which is 2% above the room relative humidity. This system provides an accurate close differential which is not appreciably affected by variations in calibration of the humidity sensing element **29** due to aging or contamination, because the same sensing element is used for measuring both room air and cover air. Similarly, variations in the resistance of the winding of rheostat **56**, in line voltage, and in the gain of the tube **58** have little or no effect on accuracy.

The differential between room and cover relative humidity can be changed by adjusting the pull-in and drop out values of relays R_2 and R_3, by adjusting their contact screws, or by changing over to a different range humidity sensing element **29**.

While a specific embodiment of a control apparatus for a mat dryer has been disclosed in the foregoing description, it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

1. In a mat dryer, a support, a curved platen on said support, said platen being apertured to allow air to pass therethrough, air heating means below said curved platen, a hollow cover having a perforated concave inner face adapted to fit over said platen and to receive a mat between said inner face and said platen, a vacuum pump connected to said cover, a constant temperature air tempering bath, a humidity sampling chamber in said bath, means to at times communicatively connect said chamber to said cover and at other times to connect said chamber to atmosphere, an electrical humidity sensing element in said chamber whose resistance changes with humidity, an energizing circuit connected to said vacuum pump and including switch means, means regulating the sensitivity of said switch means in accordance with the response of said sensing element when atmospheric air is admitted to said sampling chamber, and means operating said switch means in accordance with the change in resistance produced in said sensing element when the cover is subsequently connected to said chamber.

2. In a mat dryer, a support, a perforated curved platen on said support, air heating means below said curved platen, a hollow cover having a perforated concave inner face adapted to fit over said platen and to receive a mat between said inner face and platen, a vacuum pump connected to said cover, a constant temperature air tempering bath, a humidity sampling chamber in said bath, an electrical humidity sensing element in said chamber whose resistance changes with humidity, an energizing circuit connected to said vacuum pump and including relay means controlling said circuit, means to operate said relay means responsive to changing resistance of said humidity sensing element, said relay means having a sensitivity-adjusting element, means to first connect said chamber to atmosphere, means to operate said sensitivity-adjusting element in accordance with the response of said humidity sensing element when the chamber is connected to atmosphere, whereby to condition said relay means to the humidity in the atmosphere, and means to subsequently connect said chamber to the cover, whereby to operate said relay means in accordance with changes in humidity of the air in the cover.

3. The structure of claim **2**, and means to move the cover away from said platen responsive to the operation of said relay means.

4. The structure of claim **2**, and wherein the means to first connect the chamber to atmosphere and to subsequently connect the chamber to the cover comprises a three-way valve provided with an operating solenoid, said valve having an exit port connected to the chamber and respective inlet ports connected to atmosphere and to the cover, the exit port being connected to the cover-connected port when the solenoid is energized and being connected to the atmosphere port responsive to energization of the solenoid, means to first simultaneously energize said pump and said solenoid, whereby to connect said chamber to atmosphere for conditioning the relay means, and means to deenergize said solenoid after a predetermined time interval, whereby to connect the chamber to the cover.

5. The structure of claim **4**, and means to operate said relay means to open said energizing circuit when the humidity in the cover air decreases to a value having a relatively small differential with respect to the humidity in the atmospheric air, whereby to deenergize the vacuum pump.

References Cited by the Examiner

UNITED STATES PATENTS

1,880,114	9/1932	Smith et al.	34—53
1,960,697	5/1934	Cochran et al.	34—146 X
2,542,654	2/1951	Gadden	34—146 X
2,643,464	6/1953	Hadady	34—48

FREDERICK L. MATTESON, JR., *Primary Examiner.*

JOHN J. CAMBY, *Examiner.*

D. A. TAMBURRO, *Assistant Examiner.*