

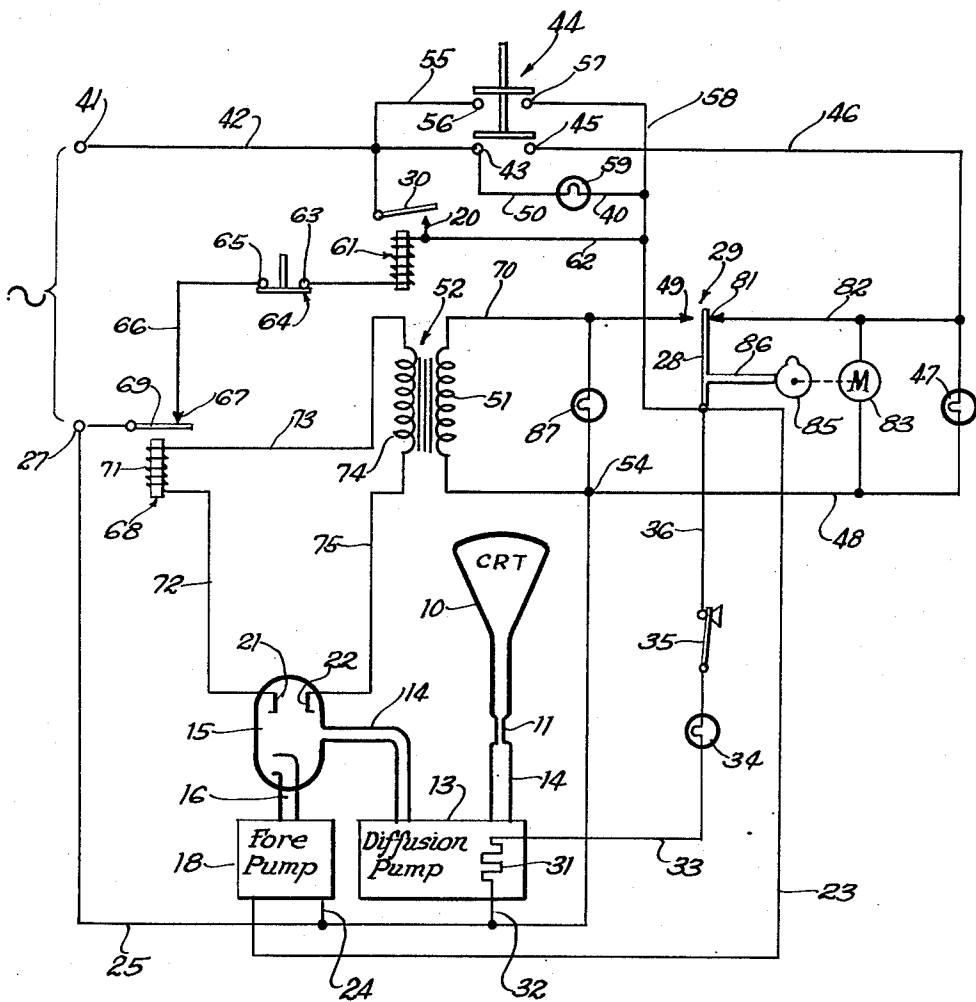
Sept. 28, 1954

W. G. TAYLOR

2,690,291

CONTROL APPARATUS FOR VACUUM PUMPING SYSTEMS

Filed July 6, 1951



INVENTOR.
Warren G. Taylor
BY
Leonard S. Thompson
Attorney

UNITED STATES PATENT OFFICE

2,690,291

CONTROL APPARATUS FOR VACUUM
PUMPING SYSTEMSWarren G. Taylor, Chicago, Ill., assignor to
American Television, Inc., Chicago, Ill.

Application July 6, 1951, Serial No. 235,461

4 Claims. (Cl. 230-17)

1

This invention relates to the exhausting of evacuated envelopes, as for example those used for cathode ray tubes. In particular it relates to an apparatus and method for automatic control of the vacuum pump in accordance with the degree of vacuum in the pumping system.

In the evacuation process, as practiced, for example, in the manufacture of cathode ray tubes, the problem of so-called "leakers" is of frequent occurrence. "Leaker" is a colloquialism for a tube envelope which has flaws of such character that a desired vacuum cannot be obtained. Such flaws may be pinholes or cracks in the glass, or, in the case of glass and metal envelopes, inadequate closing of the seams where the two materials are united, bad sealing of a "dag" button, et cetera. In the event a leaker is pumped for too long a period the air passing through the oil diffusion pump, now in common use, will eventually oxidize the oil to the point where the pump must be overhauled. Not only does this disable the pumping station involved, with consequent substantial loss of production, but the expense of servicing the pump is not insignificant. The employment of an ordinary vacuum gauge to detect a leaky envelope requires human attention, and the pressure of a leaker may not be known until after the pump has been deleteriously affected. In the foregoing connection it will be noted that, in the industry, a bank of from 10 to 20 pumping stations may be under the supervision of a single employee so that reliance upon the human element for more than a supervisory function is ruled out and the employment of automatic devices, wherever practicable, is practically a necessity.

This invention has for its principal object the provision of an apparatus automatically responsive to the vacuum existing in the vacuum pumping system whereby the pump is disabled in the event a "leaker" is encountered.

A further object is to provide apparatus as aforesaid which includes timing means for automatically controlling the function of the oil diffusion pump.

Other objects will appear as the description proceeds.

The single figure of the drawing, which shows schematically a preferred manner of carrying the invention into practice, may now be referred to. The tube being evacuated, which is shown exemplificatively as a cathode ray tube, is indicated at 10, and the usual exhaust tubulation 11 is shown diagrammatically as connected to an oil diffusion pump 13. It will be understood that, in practice, the tubulation is commonly connected

2

to the pump by means of a chuck having a resilient gripping element for rapid attachment and detachment of the tubulation at the beginning and end respectively of the pumping cycle, and such chuck is indicated at 14.

The outlet of the diffusion pump 13 is connected by a tube 14 to a trap 15 of well-known form and function, the outlet 16 whereof enters a mechanical, vane type of fore or backing pump 18. It will be understood that while both a diffusion pump and a backing pump are shown, and such arrangement is preferred for production of a hard vacuum, the invention is not to be regarded as limited to the use of two or more pumps in tandem, nor is any limitation to be inferred from inclusion in the example of particular types of vacuum pumps.

Enclosed in the trap 15, which is generally of glass and suitably supported by sealing the same in the wall thereof, is a pair of electrodes 21 and 22 across which current flow may take place, and the intensity of which is a function of the vapor pressure in the trap 15. By suitably forming, dimensioning and spacing the electrodes 21 and 22 current flow of a value calculated to actuate the control apparatus is initiated upon occurrence of a predetermined vacuum in the pumping system.

Pump 13 is provided with a driving motor (not shown), the terminals of which are connected to leads 23 and 24. Lead 24 is connected to conductor 25 which is in turn connected to one terminal 27 of any convenient source of power, e. g. 110 volts, alternating current. The other lead 23 is connected to the movable contact finger 28 of a single pole-double throw, cam-operated switch 29.

Diffusion pump 13 includes the usual heater 31, one terminal 32 of which is tapped into the conductor 25, and the other terminal 33 of which is connected to an indicator lamp 34, say of green color, which is in series with a manual on-and-off switch 35, the other side of the switch being connected by a lead 36 to the contact finger 28.

The other source terminal 41 is connected by a conductor 42 to contact 43 of a main starting switch 44 of the push-button, hold-to-close type, its companion contact 45 being connected by means of lead 46 to an indicator lamp 47, say white in color, the other side of which latter is connected by lead 48 to one terminal of the primary 51 of a transformer 52. Conductor 25 comes to a junction 54 with lead 48.

A branch 55 of conductor 42 is connected to contact 56 of main switch 44, the companion

contact 57 of which is connected by means of lead 53 to movable switch finger 28. A signal lamp 59, say red in color, is shunted across contacts 43 and 57 by means of leads 40 and 59. For holding closed the circuit first completed across contacts 56 and 57 there is provided a relay 61, one side of the coil of which is connected by a tap 92 to conductor 58, and the other side to one contact 63 of a normally closed "stop" switch 64. The related contact 65 of switch 64 is connected by a lead 66 to back contact 67 of a relay 68, the tongue 69 whereof is connected to source terminal 27.

Operating coil 71 of relay 68 is connected respectively, by lead 72, to electrode 21, and by lead 73 to the secondary 74 of transformer 52, the other side of the secondary being connected by lead 75 to electrode 22. Thus current for operation of relay 68 is provided from the transformer 52 only when the pressure in the trap 15 is of such value that the current flow between the electrodes is sufficient to operate the relay.

Right hand contact 81 of switch 29 is connected by a lead 82 to conductor 46, and a switch-operating motor 83 is shunted across leads 82 and 48. A cam 85 driven at a suitable speed, as by reduction gearing, is adapted to actuate a follower 86 coactive with switch finger 28.

A signal lamp 37, say amber in color, is shunted across primary 51.

Operation is as follows: Upon closure of main switch 44 current flows from source terminal 41 through lead 42, branch 55, contacts 56 and 57, lead 58, and lead 23 to the fore pump motor, the other terminal of this motor being constantly energized through lead 25 of the other source terminal 27. Accordingly the fore pump motor is started.

Simultaneously a holding circuit is established from terminal 27, relay tongue 69, contact 67, lead 66, normally closed switch 64, coil of relay 61, leads 62, 58 and 40, through lamp 59 and contact 43, and thence via lead 42 to source terminal 41. Accordingly the tongue 36 of relay 61 is closed against its contact 20 to shunt the contacts 56 and 57 and thereby to maintain the circuit theretofore momentarily closed through said contacts.

Closing movement of the switch 44 is also effective to energize the motor 83, for a brief period of time with which the operator rapidly becomes familiar, and will, consequently, hold switch 44 closed for that length of time. As will be explained hereinafter the motor 83 comes to rest with the rise of the cam 85 against the follower 86 and, in order to initiate a succeeding cycle, the cam must be rotated just enough to carry the rise away from its follower to restore the finger 28 to the position illustrated. Such result is achieved through a circuit traced as follows: From source at 41, lead 42, contacts 43 and 45, lead 46, lead 82, motor 83, lead 48, and lead 25 to source at 27. The configuration of the cam 85 and its speed are such that the switch 44 need be held closed for only one or two seconds to achieve the object just set forth. As soon as the finger 28 has moved to the right a circuit is established to maintain motor 83 in operation. Such circuit may be traced as follows: From source at 41, lead 42, relay tongue and contact 30 and 20, lead 62, lead 58, switch finger 28, contact 81, lead 82, through motor 83, lead 48 and lead 25 to source at 27.

Since the red lamp 59 is in parallel with the relay contacts 20 and 30 the same will be short-

circuited as soon as the relay 61 has established the holding circuit heretofore detailed. Obviously when relay contacts 20 and 30 are open the lamp 59 will provide a signal of that condition, and as will be amplified upon hereinafter.

Since the holding circuit has been established the fore pump motor may continue to run. Pumping has thus been initiated, and will continue down to a pressure of from 50 to 100 microns. Meanwhile motor 83 will rotate the cam 85. The speed of the cam may be selected to suit the predetermined pumping cycle, which, in the example, is such as to produce one revolution of the cam in five minutes. Such period has been found adequate to allow the fore pump of the example to evacuate a tube of predetermined volume down to a pressure of 50 to 100 microns. At this point it is desirable to initiate operation of the diffusion pump 13. To this end the rise on the cam 85 will have rotated to a position to actuate the follower 86 to move the finger 28 against contact 29. Consequently circuits are respectively established or interrupted as follows: First, from source at 41, lead 42, relay tongue and contact 30 and 20, lead 62, finger 28, contact 49, lead 70, primary 51, lead 48, lead 25 to source at 27 whereby the transformer 52 is placed in circuit. Second: the finger 28 leaving the contact 81 will interrupt the circuit to the motor 83 which will leave the cam rise holding the finger 28 to the left, and from which position the rise may be subsequently dislodged upon initiation of a succeeding cycle.

The heater 31 has been placed in circuit theretofore upon closing of relay 61, the path for which may now be traced: beginning with lead 58, through lead 36 and now-closed switch 35, green lamp 34, lead 33, heater 31, lead 23 to source at 27. Switch 35 is included for convenience to permit manual control of the heater at will depending upon a particular pumping procedure. Lamp 34, being in series with the heater 31, will indicate whether or not the heater is functioning. If the lamp should be dark the indication will be that either the heater or the lamp has failed. In either case service is called for.

At a pressure of from 50 to 100 microns, depending upon the size and spacing of the electrodes 21 and 22, as well as the material comprising the same, a somewhat pale, pinkish discharge becomes visible therebetween. However the path is not sufficiently conductive to complete a circuit including the secondary 74 of the transformer as a voltage source and the coil 71 of relay 68. As long as the vacuum is of the order just indicated or harder, normal evacuation may proceed, thereby indicating that the particular tube being pumped is not a "leaker." On the other hand, if a "leaker" has been encountered, the pump is unable to maintain the degree of vacuum already established. Such result may occur in various ways. For example, since the tube is being heated exteriorly while evacuation is in progress a potential leak, e. g. a tight crack, may open due to expansion of the glass, whereafter continued pumping in a normal cycle will, in most cases, deleteriously affect the oil in the aspirator 13. Leakers may also occur in cathode ray tubes having a high voltage connection, sometimes called a "dag button" and wherein improper union of the button with the glass or poor annealing may result in a crack during baking. Sometimes the rubber sealing ring forming part of the chuck indicated at 14,

5

and previously described, may not be effective, in which case leakage may occur between the tubulation and ring, or through the ring itself. Regardless of the cause it is desirable to terminate pumping to save the aspirator from damage.

Accordingly loss of vacuum will permit an intensification of the discharge between electrodes 21 and 22 with consequent increased conduction thereacross to complete a circuit including the secondary 74 and coil 71 of relay 68. As a result tongue 69 is retracted from its contact 67 to break the circuit through holding relay 61. Thus the fore pump motor is disabled and evacuation terminated. At the same time the red lamp 59 is illuminated to provide a visual indication of difficulty at the pumping station involved.

The construction and arrangement of the electrodes 21 and 22 is such that conduction thereacross of current sufficient to actuate the relay 68 will occur at a vacuum of from 50 to 100 microns. However it is obvious that such range of vacuum is set out by way of example only.

The sensitivity of the circuit including the electrodes may be adjusted in one way by changing their area, a larger area yielding increased sensitivity.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto, since many modifications may be made, and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a vacuum pumping apparatus including a pump driven by a prime mover, a source of power for said prime mover, a trap forming part of the exhaust side of the apparatus and having its entire volume at the same pressure as the vessel being evacuated, a pair of spaced-apart electrodes supported within said trap, a relay, a circuit including a source of power, the operating coil of said relay and said electrodes in series, and a circuit including the contacts of said relay, prime mover and source of power, said relay being operable upon occurrence of a predetermined state of vacuum in said trap to interrupt said second circuit.

2. A vacuum pumping apparatus comprising a diffusion pump to which the vessel being evacuated may be connected, a mechanical backing

6

pump, a fluid connection between said pumps, said connection being subject throughout its volume to the same pressure as the vessel, a pair of spaced-apart electrodes mounted within said connection, a circuit including a switch and a power source for controlling the operation of said backing pump; a second circuit including said electrodes, a source of power and means for controlling said switch, whereby upon the occurrence of a predetermined state of vacuum in said connection current flow between said electrodes is effective to actuate said switch to disable said mechanical pump.

3. A vacuum pumping apparatus comprising a vacuum pump, an electric motor for driving said pump, a source of power for said motor, a relay, circuit means including a pair of the relay contacts for controlling said motor, a fluid connection for connecting the vessel to be evacuated to said pump, said connection being subject throughout its volume to the same pressure as the vessel, a pair of electrodes mounted within said connection, second circuit means including the operating coil of said relay, said power source and said electrodes whereby upon occurrence of a predetermined state of vacuum in said connection current flow between said electrodes is effective to energize said relay to disable said motor.

4. A vacuum pumping apparatus comprising a pump, a prime mover for said pump, a conduit for connecting the vessel to be evacuated to said pump, said connection being subject throughout its volume to the same pressure as the vessel, a pair of electrodes supported within said conduit, a source of electric power, and circuit means including said prime mover, electrodes and source for disabling said prime mover upon current flow between said electrodes incident upon occurrence of a predetermined state of vacuum in said conduit.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
703,120	Danley	June 24, 1902
905,973	Zeitlin	Dec. 8, 1908
1,347,194	Washington	July 20, 1920
1,775,531	Kramer	Sept. 9, 1930
1,972,986	Gardeen	Sept. 11, 1934
2,147,422	Bendz	Feb. 14, 1939
2,240,607	Buck	May 6, 1941