

Feb. 13, 1962

J. M. ALLERDICE ET AL
LABORATORY FUME HOOD DOOR

3,021,130

Filed Oct. 4, 1956

2 Sheets-Sheet 1

Fig. 1

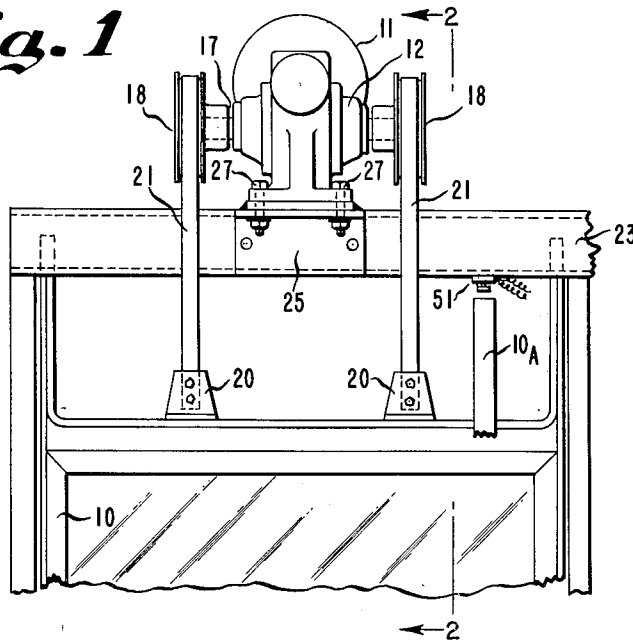
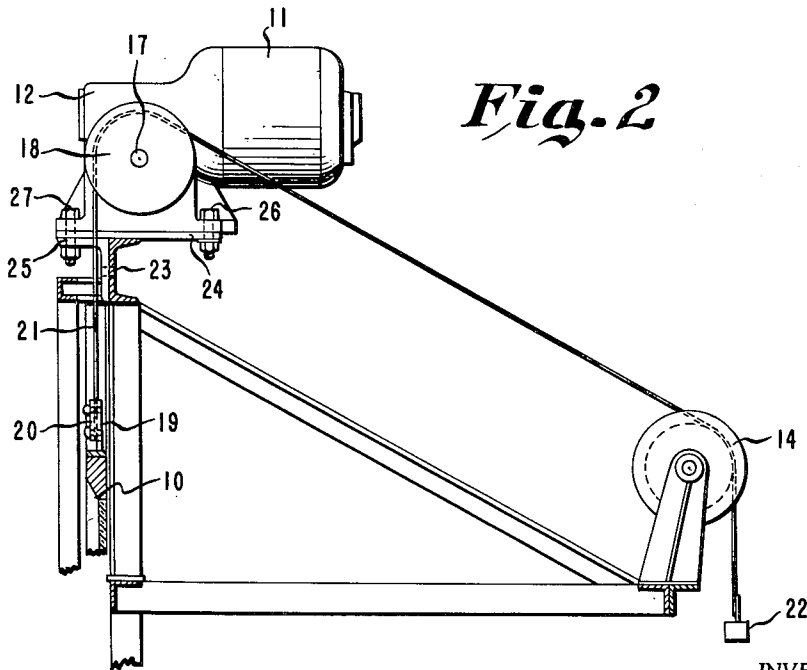


Fig. 2



INVENTORS

JOSEPH M. ALLERDICE
TRAVIE W. STRICKLIN, JR.

BY

Harry J. McCauley

ATTORNEY

Feb. 13, 1962

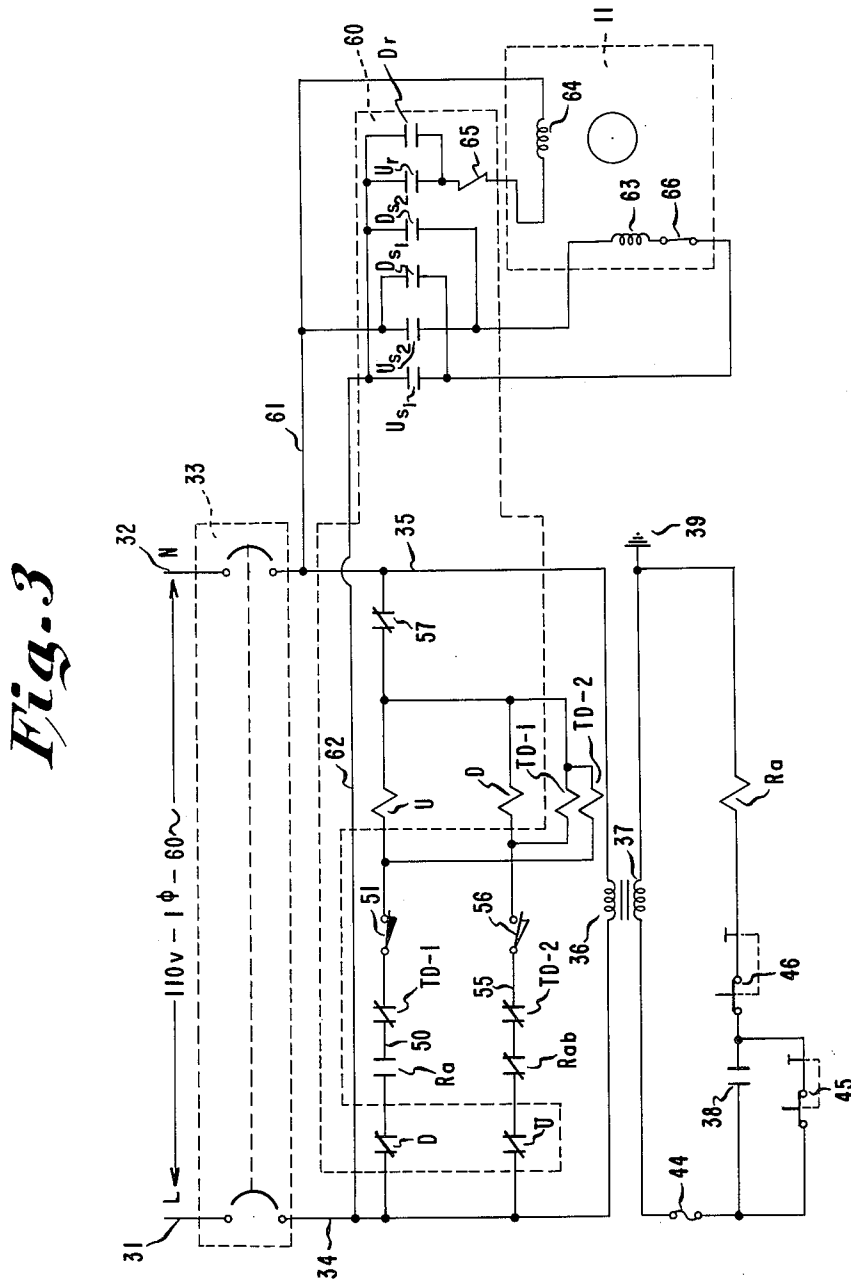
J. M. ALLERDICE ET AL

3,021,130

LABORATORY FUME HOOD DOOR

Filed Oct. 4, 1956

2 Sheets-Sheet 2



INVENTORS

JOSEPH M. ALLERDICE
TRAVIE W. STRICKLIN, JR.

BY

Harry J. McCauley

ATTORNEY

1

2

3,021,130

LABORATORY FUME HOOD DOOR

Joseph M. Allerdice, Landenberg, Pa., and Travie W. Stricklin, Jr., Wilmington, Del., assignors to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

Filed Oct. 4, 1956, Ser. No. 613,889

2 Claims. (Cl. 268—42)

This invention relates to fume hoods for chemical laboratories and the like, and particularly for chemical laboratories which are air-conditioned.

Recently, attempts have been made to air-condition chemical laboratories; however, the exhaust air requirements of conventional fume hoods have been so great that it is economically not feasible to provide this desirable service. The necessity for prompt closing of laboratory fume hood doors has placed an additional duty on the laboratory worker and, at the same time, the construction of conventional fume hoods is such that, even with prompt closing of the hood doors, such large amounts of room air are lost through the hoods that it is impossible to maintain conditions sufficiently stable to effect satisfactory air-conditioning.

A primary object of this invention is to provide a laboratory fume hood which is adapted for use in air-conditioned laboratories. Another object of this invention is to provide a laboratory fume hood wherein the hood doors are automatically operated without effort on the part of the laboratory worker. Other objects of this invention are to provide an automatically actuated laboratory hood door which is quick-acting, reliable in operation, low in first cost and maintenance and, finally, to provide an apparatus which is adapted for incorporation in present hood installations without extensive structural changes. The manner in which these and other objects of this invention are accomplished will become apparent from the detailed description and the following drawings, in which:

FIG. 1 is a front elevation of a single laboratory hood door provided with automatic actuation according to this invention,

FIG. 2 is a sectional view taken on line 2—2 of FIG. 1, and

FIG. 3 is a circuit diagram of the electrical circuit for the apparatus of FIGS. 1 and 2.

Generally, this invention comprises providing a laboratory hood door with dimensions restricted to limits wherein, at fully open position, no more than a tolerable amount of conditioned room air will exhaust therethrough provided with an automatic actuation device which is controlled by the foot of the laboratory worker.

Referring to FIGS. 1 and 2, a typical installation comprises a laboratory hood provided with a multiplicity of hood doors 10 which cooperate one with another along the side edges to close off the entire front expanse of the hood, which may be any usually encountered size. We have found that a convenient hood door size for ordinary analytical and research service is one wherein the over-all width of the door is 30". A total vertical opening of about 36" is normal and it is customary to allow free overhead space of about this extent in laboratory rooms.

The preferred embodiment of this invention shown in FIGS. 1 and 2 utilizes independent powering means for each laboratory hood door, although it will be apparent that many different arrangements of drive for a plurality of doors is possible. The motor 11 may be a single phase, split phase type, reversible small fractional H.P., 60 cycle motor provided with an integral speed reducer 12 having a reduction ratio of 48:1, yielding a 35.9 r.p.m. output.

Reducer 12 is provided with a through-going output shaft 17, each end of which is provided with a cast iron drive sheave 18. The hood door is provided with bolted two-part clamp fittings, one part 19 of the fittings being welded at the lower edge to the upper part of the frame at 5" spacings on opposite sides of the frame centerlines and the other part 20 being secured to one end of flat steel straps 21, threaded over drive sheaves 18, which are attached at the other end to counterweights 22. Guide sheaves 14, also preferably fabricated from cast iron, provide rear supports over which are trained the straps 21. Counterweights 22 are proportioned so as to approximately counterbalance the weight of hood doors 10 while still preserving enough driving friction between sheaves 18 and straps 21 so that the hood doors are opened and closed positively by operation of motor 11. The use of cast iron sheaves in conjunction with steel support straps 21 has the advantage that there is a relatively low coefficient of friction between straps and sheaves due to the lubricating effect of the graphite in the cast iron, thus making it possible for the laboratory worker to readily operate the hood doors manually in the event of power failure or emergencies in which it might be desirable to override motor 11 even when the motor is operating normally. As seen in FIG. 2, with powered operation when sheaves 18 are driven in a clockwise direction, straps 21 will lower counterweights 22 and open hood doors 10, whereas rotation of sheaves 18 in the counterclockwise direction will cause hood doors 10 to take closed position under their own weight. With the apparatus described, only about 4½ seconds time is required to open or close the door to the full extent of 36".

The construction detailed in FIGS. 1 and 2 utilizes an overhead mounting of motor 11, which is relatively simple, in that all that is required is the presence of a horizontal channel member 23 to the upper edge of which is secured a motor-supporting bedplate 24 and a front steadying angle iron 25. The motor is attached to bedplate 24 in the rear with bolts 26 and to the bedplate and angle iron 25 at the front with bolts 27. Channel 23 can be bolted to the hood framework or supported by independent structures, whichever is convenient. It will be understood that other dispositions of the motor are equally practicable, including arrangements to the side of the hood or even below the hood workspace, if desired, in which case other arrangements of driving and guiding sheaves may be had to satisfy convenience. Limit switch 51, hereinafter described, is mounted on channel 23 in line with vertical arm 10A, so as to be opened when hood door 10 is open to the upper limiting extent.

It is convenient to operate hood doors 10 through a floor mat switch which the laboratory worker can operate by his body weight in stepping into working position before the hood itself. One circuit arrangement, which is useful where single phase motors are employed in hood door actuation, is shown in FIG. 3.

All of the operating power is derived from leads 31 and 32, which are conventional 110 v., single phase, 60 cycle power leads usually found in chemical laboratories. Preferably, leads 31 and 32 are connected to the apparatus of this invention through a conventional circuit breaker indicated generally at 33. The output from circuit breaker 33 passes through leads 34 and 35 to the primary winding 36 of a conventional 110 v./12 v. transformer. The secondary low voltage winding 37 of the transformer is connected through mat switch 38 to ground 39. The mat switch operating circuit is protected by a conventional fuse 44 and switch 38 is shunted by open lockout maintained-contact switch 45. In addition, a close lockout maintained-contact switch 46 and a relay coil R_a, with contacts R_a and R_{ab} hereinafter described,

are provided in series circuit with mat switch 38 to ground 39. A branch circuit indicated generally at 50 is connected in parallel with winding 36 between leads 34 and 35 and a second branch circuit 55 is connected in parallel with branch circuit 50 from lead 34.

Branch circuit 50 includes, in series, a set of normally closed down operation interlock contacts D, a set of normally open contacts R_a , a set of normally closed time delay relay contacts TD-1, upper limit switch 51 and upward operating relay coil U. Branch circuit 55 includes, in series, a set of normally closed up operation interlock relay contacts U, normally closed relay contacts R_{ab} , a set of normally closed time delay relay contacts TD-2, lower limit switch 56, and downward operating relay coil D. As indicated by the broken line block, interlock relay contacts D and U and upward operating relay U, controlling contacts U, and downward operating relay D, controlling contacts D, are integral components of the combination reversing magnetic starter 60 hereinafter described in greater detail. An overload relay contact pair 57 is provided in the common connector between circuits 50 and 55 and lead 35 to provide protection to both. A time delay relay coil TD-1 is connected in shunt around downward operating relay coil D and a time delay relay TD-2 is connected in shunt around upward operating relay coil U, the purpose for which is hereinafter explained.

Motor 11 is operated from the combination reversing magnetic starter 60 which is supplied with power from leads 61 and 62 connected past circuit breaker 33. As is conventional in split phase motors, 11 is provided with a starting winding, indicated schematically at 63, and a running winding, indicated schematically at 64. Normally open relay contacts U_r and D_r are connected in parallel with one another between lead 62 in series with running winding 64 to lead 61. Motor 11 is provided with an integral centrifugal switch 65 in series with starting winding 63 and across the motor powering leads.

Normally open relay contacts U_{s1} and U_{s2} responsive to relay coil U are provided in series circuit with starting winding 63 between leads 62 and 61. For downward operation, normally open relay contacts D_{s1} and D_{s2} responsive to relay coil D are provided in reverse current flow connection respectively with contacts U_{s1} and U_{s2} and in series with starting winding 63 between leads 62 and 61. Preferably, an overload switch 65 is provided in the running winding circuit to protect motor 11 against overloads.

In operation, it will be understood that when hood door 10 is closed to bottom limiting position, the condition represented in FIG. 3, lower limit switch 56 is opened, preventing current flow through branch circuit 55. This lower limiting position is preferably such as to leave an opening between the lower edge of the hood door and the hood floor of about $1\frac{1}{2}$ ", so that there will be a minimum effective purge of the inside of the hood in order to always remove any fumes or the like released within the hood even when the hood doors are closed to the fullest extent. Similarly, when hood door 10 is in fully opened position, upper limit switch 51 is opened by arm 10A integral with the door, preventing passage of current through branch circuit 50. However, at any positions of hood door 10 other than full opening, limit switch 51 remains closed, retaining branch circuit 50 in operative condition.

For purposes of explanation, if it is assumed that hood door 10 is closed and the laboratory worker desires to open it, he steps on mat switch 38, thereby energizing relay coil R_a through transformer windings 36 and 37. At this instant, hood door 10 is, of course, closed to its lower position and lower limit switch 56 is open. Energization of relay coil R_a thereupon closes normally open relay contacts R_a , thereby energizing relay coil U. Down operation interlock contacts D remain closed due to the

fact that relay coil D remains de-energized, lower limit switch 56 being open. Energization of relay coil U immediately closes relay contacts U_{s1} , U_{s2} and U_r in starter 60, thereby powering both starting winding 63 and running winding 64. As is conventional, centrifugal motor switch 66 throws out when motor 11 reaches from 50-80% synchronous speed, motor 11 thereupon continuing to operate as an induction motor. Relay coils TD-2, operating in conjunction with relay coil U, and TD-1, operating in conjunction with relay coil D, possess an inherent time delay on de-energization of the order of 1 or 2 seconds to insure that, on reversal of operation of motor 11, centrifugal motor switch 66 will always be closed before the contacts TD-2 and TD-1 completing the circuit through the U and D contacts, respectively, of starter 60 are closed, so that high torque operation with both starting and running windings energized is always obtained.

As long as the laboratory worker retains mat switch 38 closed by his own weight, hood door 10 continues to rise to the point where the window is fully open, whereupon upper limit switch 51 opens, immediately de-energizing relay coil U and opening all of the contacts U_{s1} , U_{s2} and U_r . At the same time, normally closed up operation interlock contacts U in branch circuit 55 are restored to closed position. The laboratory worker may now do any work within the hood which he desires without any attention to the hood door operating mechanism. If he desires to leave his position upon mat switch 38 while still retaining hood door 10 open, he can lock the door in open position by depressing the button of open lockout switch 45 shunted around mat switch 38.

After the worker has completed his duties within the hood, he can remove himself from his position on mat switch 38 whereupon, with lockout switch 45 open, the circuit is automatically operative to close the hood door. This results from the fact that mat switch 38 is now open, thus de-energizing relay coil R_a , which allows relay contacts R_{ab} to resume their normally closed position. Since the weight of hood door 10 is removed from lower limit switch 56, the switch is in closed position. This permits energization of relay coil D, except for contacts TD-2 which remain open for the delay period of 1 or 2 seconds incident to the de-energization of time delay relay TD-2. After this slight interval contacts TD-2 are restored to their normally closed position and relay coil D is energized, thereupon closing contacts D_{s1} , D_{s2} and D_r in magnetic starter 60. At the same time, safety down operation interlock contacts D in branch connection 50 are opened, insuring against possible simultaneous operation of the mechanism in the upward sense. Time delay relay coil TD-1 operates with an inherent delay or de-energization of about 1 or 2 seconds in the same manner as relay coil TD-2, but in conjunction with relay coil D, and serves a similar purpose as coil TD-2. Except for the possible brief delay interval required for closure of the TD-2 contacts, hood door 10 immediately moves downwardly, eventually reaching closed position, when the weight of the door opens lower limit switch 56 which immediately de-energizes relay coil D, thereby stopping motor 11. If it is desired to lock the hood door in closed position, the operator may open close lockout switch 46, whereupon depression of mat switch 38 will not open the hood door.

The purpose of time delay relays TD-1 and TD-2 is to insure safe inactivation of starting winding 63 during quick successive opening and closing operation of the hood doors, so that the split phase motor will always operate positively in the sense desired. It will be understood that other designs of motors, such as the conventional three phase induction motor, do not require time delay auxiliaries; however, cost considerations favor the construction hereinabove detailed.

The design hereinbefore detailed permits the operator to override motor 11 in the event of emergency or power

5

failure by opening or closing hood doors 10 manually in the usual manner, whereupon straps 21 slide freely over sheaves 14 and 18 with only slight resistance, thereby retaining complete freedom of manual operation while at the same time enabling powered operation as the normal course. While individual drive sheaves 18 have been shown associated with individual straps 21, it will be apparent that a single wide face sheave can be employed to drive a plurality of straps if desired.

In service it has been found that the apparatus of this invention permits unhampered performance of the duties of laboratory personnel and, in fact, frees them from the manual exertion necessary to open conventional hood doors. At the same time, the magnitude of room air supply requirements is reduced to the order of approximately 10% or less of that which would normally be the case, thereby making air-conditioning of laboratories economically feasible. Furthermore, there is a safety advantage in utilization of automatic hood door operation, in that the hood doors are thereby almost always closed and personnel are consequently protected against explosions or fires occurring within the hood confines.

It will be apparent from the foregoing that extensive modifications of the basic principle of this invention are possible without departure from its essential spirit, wherefor it is intended to be limited only within the scope of the following claims.

What is claimed is:

1. A laboratory fume hood door operating apparatus comprising in combination a reversible motor, a door support strap driving sheave driven by said motor, at least one door support strap threaded over said driving sheave

6

connected at one end to the fume hood door and at the other end to a movable counterweight counterbalancing at least part of the weight of the fume hood door, a normally open weight-operated switch disposed in front of said laboratory hood door, a reversing magnetic starter in circuit between said motor and the power supply for said motor, a first powered relay coil operating said magnetic starter to actuate said motor to raise said hood door to open position when said weight-operated switch is closed and a second powered relay coil operating said magnetic starter to actuate said motor to lower said hood door to closed position when said weight-operated switch is open.

2. A laboratory fume hood door operating apparatus according to claim 1 wherein said reversible motor is a single phase reversible motor provided with a starting winding, a running winding and a centrifugal switch adapted to open at a predetermined speed to open the circuit to said starting winding of said motor, thereby permitting operation as an induction motor, a first time delay relay coil connected in shunt with said first powered relay coil with contacts in series between said power supply and said second powered relay coil, and a second time delay relay coil connected in shunt with said second powered relay coil with contacts in series between said power supply and said first powered relay coil.

References Cited in the file of this patent

UNITED STATES PATENTS

30	1,989,148	Peelle	Jan. 29, 1935
	2,253,170	Dunham	Aug. 19, 1941
	2,639,142	Morgan et al.	May 19, 1953

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,021,130

February 13, 1962

Joseph M. Allerdice et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 53, for "or" read -- on --; line 68, for "wil" read -- will --.

Signed and sealed this 19th day of June 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents