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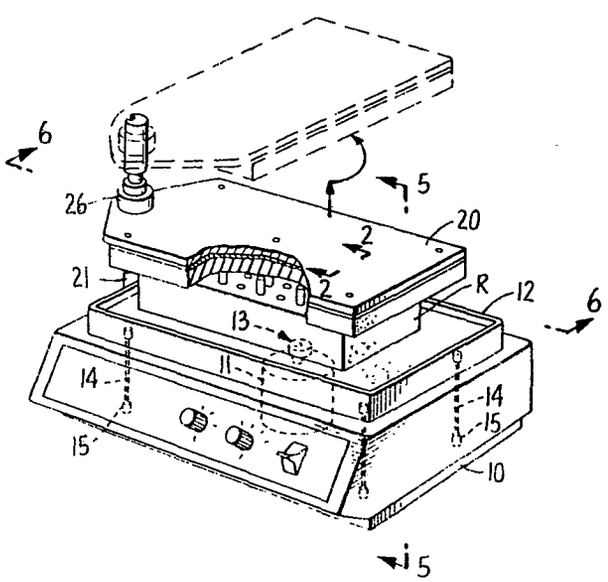
(54) Vortexer.

(57) A vortexer apparatus having a hold-down plate (20) detachably mounted onto an upright cylindrical support (21), said support having a pair of splines (21a, 21b) formed thereon, the end of one spline being spaced from the near end of the other spline by a circumferential groove (21c) said hold-down plate being supported from an elongate sleeve (26) axially engageable with said support, and having a key (27) engageable with said pair of splines. A torque arm (23) is provided for selectively locating the cylindrical support and hold-down plate relative to a base and an agitated platform (12).



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The present invention relates generally to apparatus for producing a vortex and to the mixing of liquids contained in laboratory vessels such as test tubes.

In brief, this invention provides both an improved structural arrangement for supporting a hold down plate relative to a base and an agitated platform and an improved motor control circuit for initiating the formation of a vortex.

Motor control circuits for existing vortexers customarily provide circuitry for operating the motor with time control or, alternatively, in a continuous mode of operation. Speed control circuits have also been utilized. The present invention, however, provides an improved motor control circuit wherein the electric motor is energized to produce an immediate vortex although the speed control may be set extremely low. This feature is of particular advantage in overcoming the intertia of rest characteristic of such systems, and to assure consistency in the result of a timed cycle of operation.

The present invention provides a vortexer apparatus having a base, a motor mounted to said base, an agitated platform resiliently supported from said base and connected to said motor by an eccentric crank, and a hold down plate, characterized by an upright cylindrical support mounted to said base, said support having a pair of

splines formed thereon, the end of one spline being spaced from the near end of the other spline by a circumferential groove; and means for detachably mounting said hold down plate to said support including an elongate sleeve axially engageable with said support and having a key engageable with said pair of splines and groove; whereby said plate may be selectively mounted on said support at alternative positions, said key being engageable with either one of said splines or with said circumferential groove.

The present invention also provides a control circuit for an electric motor of a vortexer comprising a primary control line including a primary control switch for starting and stopping the motor; means for applying a current to said primary control line; means for operating said primary control switch and selectively conditioning said primary control line to be either conductive or non-conductive; a speed control circuit including a secondary control line connected to said primary control line for pulsing the current flow and varying the pulse width of the current carried through said primary control line; and a start-up control line connected to said primary control line for conducting a current of substantially full pulse width for a time period sufficient to overcome the intertia at rest of the vortexer and supported apparatus.

The objects and features of this invention will become apparent in view of the following detailed description.

In the drawings forming a part of this application and in which like parts are identified by like reference numerals,

Fig. 1 is a perspective view of a preferred embodiment of the invention in a vortexer apparatus;

Figs. 2, 3 and 4 illustrate various sizes of laboratory vessels and holders which may be used with the vortexer apparatus;

Fig. 5 is an elevation of the vortexer viewed on line 5-5 of Fig. 1;

Fig. 6 is an elevation of the vortexer viewed on line 6-6 of Fig. 1;

Fig. 7 is a plan view and partial section taken on line 7-7 of Fig. 6; and

Fig. 8 is a schematic of the motor control circuit.

Referring to Figs. 1, 5 and 6 in particular, the vortexer apparatus generally comprises a base 10, a motor 11 mounted to said base, an agitated platform 12 resiliently supported from the base and connected to motor 11 by an eccentric crank and coupling 13. Agitated platform 12 is resiliently supported upon a set of four wires 14, the lower end of each wire being secured in a holder 15 mounted to base 10. A housing 16 essentially encloses motor 11, wire 14 and the operating circuitry of the vortexer. This arrangement of apparatus is essentially known and is utilized in connection with other forms of vortexer apparatus.

The present invention is more especially directed to the means provided for mounting a hold down plate 20 relative to agitated plate 12 and base 10. For this purpose there is provided a cylindrical support spindle 21, secured to base 10 by a screw 22, and amintained upright by housing 16. A torque arm 23 is fitted to the lower portion of support spindle 21, and made a part thereof either with a force fit or by welding, and the torque arm is secured to the housing 16 by a set screw 24. Torque arm 23 is provided with a slot 23a which allows the torque arm to be angularly pivoted relative to the base through small angles of adjustment and then secured by set screw 24 when properly located. Slight angular adjustments of the torque arm and support spindle 21 are made by an eccentric 25 threadably received in housing 16. The upper end of eccentric 25 carries a pin 25a, said pin being offset relative to the axis of threading and received in an opening 23b of the torque arm. This arrangement is best shown in Fig. 7.

The angular orientation of support spindle 21 is of importance in locating the hold down plate 20 directly above agitated platform 12. The mechanism provided for angularly positioning spindle 21 allows this to be done quite easily at the time of assembly, notwithstanding a manufacture of parts which may vary slightly in size and be built to loose tolerances.

Support spindle 21 is formed with a pair of splines 21a and 21b, the lower end of upper spline 21a being spaced from the upper end of lower spline 21b by a circumferential groove 21c. It will be further noted that the pair

of splines 21a and 21b are formed on opposite sides of support 21 in an axial misalignment relative to each other.

Plate 20 is adapted to be mounted to and supported from spindle 21 through an elongate sleeve 26, the internal diameter of sleeve 26 being only slightly greater than the outer diameter of support spindle 21. A key 27 is secured to sleeve 26, said key being engageable with either of said pair of splines 21a or 21b, or groove 21c, when properly aligned therewith. In the position shown in Figs. 5 and 6, key 27 is engaged with spline 21b, and in that position allows hold down plate 20 to be lowered upon a set of laboratory test tubes T supported in a rack R. Although the weight of plate 20 may be sufficient to hold the upper ends of each tube T in a relatively fixed or steady position, the hold down pressure may be increased. For this purpose a set screw 28 is provided to secure sleeve 26 at a set position along support spindle 21. To increase the pressure above that provided by the weight of plate 20 alone, hand pressure is applied to the top of plate 20 with set screw 28 backed off. With the desired or necessary pressure applied, set screw 28 is then threaeded into engagement with the surface of spindle 21. If desired, indentations may be formed along spindle 21 to receive the end of the set screw in various "set" positions.

Fig. 1 illustrates in broken line a position for hold down plate 20 allowing removal of rack R and test tubes T. This position is attained simply by backing off set screw 28, lifting table 20 until key 27 extends beyond

spline 21b and becomes aligned with groove 21c, and then rotating plate 20. Key 27 will then track within groove 21c supporting table 20 at that position.

It will be further seen that table 20 and sleeve 26 may be removed entirely from spindle 21 by simply rotating plate 20 until key 27 becomes aligned with groove 21a, then lifting the table and sleeve 26 axially from the spindle support.

Figs. 2, 3 and 4 illustrate various types of racks and vessels which may be utilized in connection with the vortexer. Such racks and vessels are commonly known and used in connection with other vortexers.

Fig. 8 is a schematic of a preferred embodiment of a control circuit for energizing an electric motor in accordance with this invention. Referring thereto, motor 11 is adapted to be energized with a pulsating DC current through an energizing circuit, including the rectifying bridge 31, a darlington pair of switches 32 and 33, and a control switch 34. The base of control switch 34 is optically coupled to a control circuit through an integrated circuit 35 including an LED. For purposes of this invention, both the energizing circuit and the optical coupler 35 are considered part of the prior art.

This invention more particularly relates to the control circuit for operating the LED of circuit 35, both with respect to time and duration, as to control and energize motor 11.

The preferred embodiment of control circuit shown comprises a primary control line 36, including a primary control switch 37. Control line 36 is connected to a rectifying bridge which serves as a means for applying a direct current thereto. A pulsing of the current flow through control line 36 is produced by a speed control circuit, including a secondary control line 38 connected to line 36 through a diode 39, an integrated circuit 40, and a ground line 41. The integrated circuit 40 is commercially known and available as a timer circuit, and is currently sold by Signatics, Inc. under the trade designation NE555. The functional pin arrangement of this integrated circuit is as follows:

GND	1	8	VCC
TRIGGER	2	7	DISCHG
OUTPUT	3	6	THRESH
RESET	4	5	CONTROL

Integrated circuit 40 operates as a multivibrator in connection with a pair of variable resisters 42 and 43 and a capacitor 44. Variable resisters 42 and 43 serve as low and high speed adjustments respectively. An adjustment of the variable resistances, it will be understood, controls the pulse width of the signal generated by the multivibrator and an adjustment in resistance varies the pulse width or duty cycle. It will be further apparent that this operation also controls the duty cycle and frequency of the current flowing through control line 36, secondary control line 38 and ground line 41.

The control circuit shown may be energized either on a time control basis or continuously. A manually operated switch 45, having a pair of moveable contacts 45a and 45b, controls the on-off time of switch 37. When switch 45 is operated to place moveable contacts 45a and 45b to the "on" position, a positive current flows to the base of switch 37 through line 46, resistance 47 and a control line 48.

In the "time" mode of operation, switch 45 is operated to momentarily place the moveable contacts 45a and 45b in their alternate positions. A positive current then flows to the base of switch 37 from an integrated circuit 49 which is identical to the integrated circuit 40. Placing the moveable contact 45b on the fixed contact related to "time" connects pin 2 of the integrated circuit 49 to ground and by reason of its timer configuration a positive current flows to the base of switch 37 through a diode 50. The duration of this condition of operation is determined by the setting of a variable resister 51, a fixed resistance 52 and a capacitor 53. When capacitor 53 becomes charged, pin 3 of integrated circuit 49 and the base of switch 37, assume ground potential. Switch 37 then opens.

An important feature of the present invention is in providing an initial high starting current for energizing motor 11. This is accomplished with a start-up control line 54, including a diode 55 and a switch 56. This start-up control line provides a flow path from primary control line 36 for conducting a current having substantially full pulse width. But the time or duration of the

current flow through switch 56 is only momentary or of a period sufficient to overcome the inertia at rest of the vortexer and supported apparatus. The base of switch 56 connects to control line 48 through a resistance 57, and a capacitor 58 is provided between resistance 57 and ground. The values of resistance 57 and capacitor 58 are then chosen to close switch 56 after a selected time period. It has been found that 15 to 20 milliseconds is adequate to overcome the energy of rest characteristic of one type of vortexer and its supported apparatus.

An example of those values and standard components which have been found useful in constructing the preferred embodiment are shown in the following tables:

Reference Designation	Value
R1, R4, R5 R6, R8, VR3	10K Ω
R2	82K Ω
R3	100 Ω
R7	1.8K Ω
R9	5.6K Ω
R10	68K Ω
VR1	5 meg Ω
VR2	25K Ω

Reference Designation	Value
C1	220 μf
C2, C3, C8	1 μf
C4, C7	.01 μf
C5	10 μf
C6	.0022 μf

Reference Designation	Part Number
D1-D4, D6	MR502
D5	MR852
D7-D10	IN4001
D11-D14	IN4148
Q1	2N6308
Q2, Q3	A5T5059
Q4	2N2222
Q5	2N2907
1C1	UA78L12
1C2, 1C3	NE555
1C4	TIL-111

Although a preferred embodiment of the invention has been illustrated and described, various modifications and changes may be resorted to without departing from the scope of the attached claims, and each of such modifications and changes is contemplated.

1. A vortexer apparatus having a base, a motor mounted to said base, an agitated platform resiliently supported from said base and connected to said motor by an eccentric crank, and a hold down plate, characterized by an upright cylindrical support mounted to said base, said support having a pair of splines formed thereon, the end of one spline being spaced from the near end of the other spline by a circumferential groove; and means for detachably mounting said hold down plate to said support including an elongate sleeve axially engageable with said support and having a key engageable with said pair of splines and groove; whereby said plate may be selectively mounted on said support at alternative positions, said key being engageable with either one of said splines or with said circumferential groove.

2. The vortexer apparatus of claim 1, characterized by the feature that said pair of splines are formed in an axial misalignment relative to each other, a rotation of said plate and sleeve being necessary to move said key from an alignment with one spline to an alignment with the other spline.

3. The vortexer apparatus of claim 1 or 2 characterized by a torque arm for rotationally locating said cylindrical support on said base, said torque arm being secured to said support and having a slot engageable with a set screw threaded to said base.

4. The vortexer apparatus of claim 3, characterized by the feature that said torque arm has an opening; and an eccentric mounted to said base, said eccentric having a pin received in the opening of said torque arm, the rotational position of said eccentric locating said torque arm and cylindrical support relative to said base.

5. The vortexer apparatus of claim 1, 2, 3 or 4, characterized by a set screw threadably secured in said sleeve and engageable with said cylindrical support when said key is engaged with the lower one of said pair of splines.

6. A control circuit for an electric motor of a vortexer comprising a primary control line including a primary control switch for starting and stopping the motor; means for applying a current to said primary control line; means for operating said primary control switch and selectively conditioning said primary control line to be either conductive or non-conductive; a speed control circuit including a secondary control line connected to said primary control line for pulsing the current flow and varying the pulse width of the current carried through said primary control line; and a start-up control line connected to said primary control line for conducting a current of substantially full pulse width for a time period sufficient to overcome the inertia at rest of the vortexer and supported apparatus.

7. The control circuit of claims 6, characterized by the feature that said primary control line includes an optical coupling for operating a motor energizing circuit.

8. The control circuit of claim 6 or 7, characterized by the feature that said primary control switch comprises a first electronic switch having a control base, said start-up control line including a second electronic switch having a control base connected to the control base of the primary control switch through a resistance, and a capacitor connected between said resistance and a ground, the value of said resistance and capacitor being selected to open said second electronic switch momentarily after said primary control switch closes.

9. The control circuit of claim 6, 7 or 8, characterized by the feature that said means for operating said primary control switch includes a timer circuit and an on-off control circuit.

10. The control circuit of claim 6, 7, 8 or 9, characterized by the feature that said speed control circuit comprises a multivibrator and means for selectively changing and setting the duty cycle of said multivibrator.

11. The control circuit of claim 6, 7, 8 or 10, characterized by the feature that said means for operating said primary control switch comprises an NE-555 integrated circuit having its output pin connected to the base of said primary control switch through a diode.

12. The control circuit of claim 6, 7, 8 or 9, characterized by the feature that said speed control circuit comprises an NE-555 integrated circuit having its output pin connected to said primary control line through a diode.

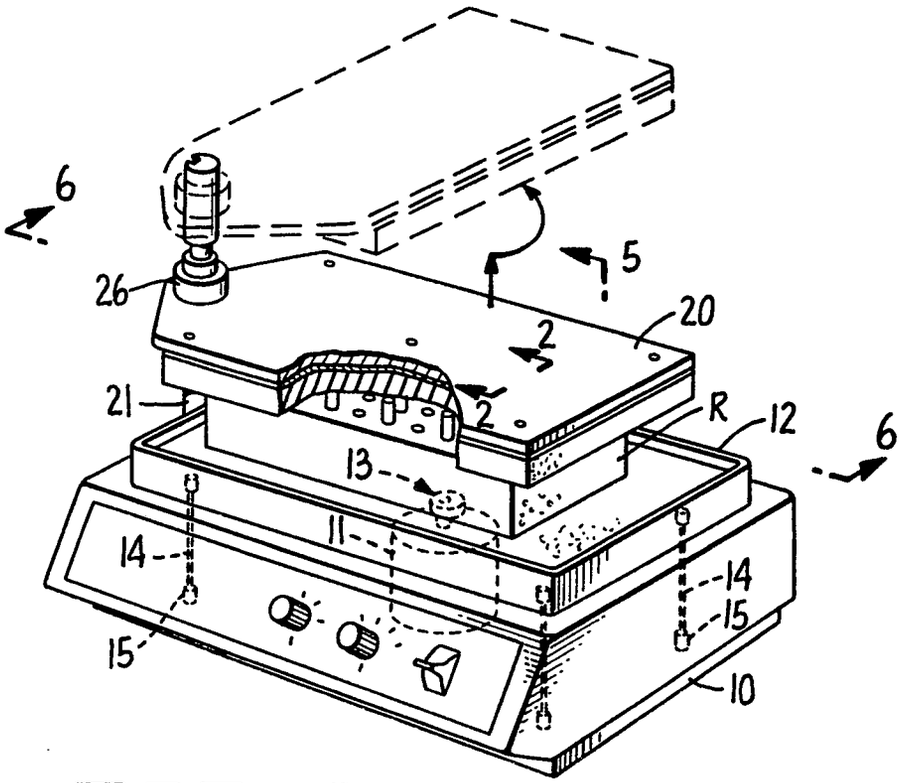


FIG .1.

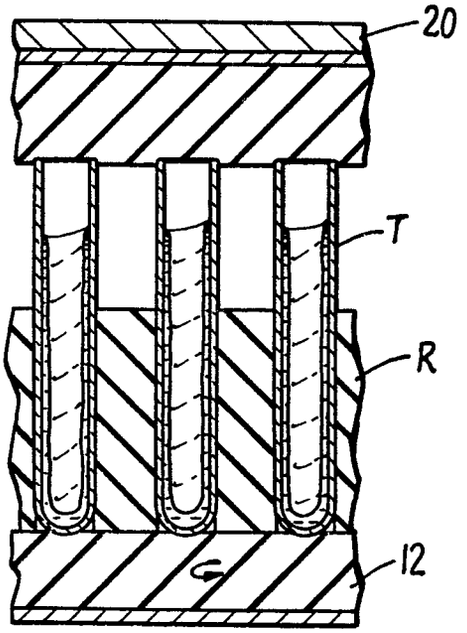


FIG .2.

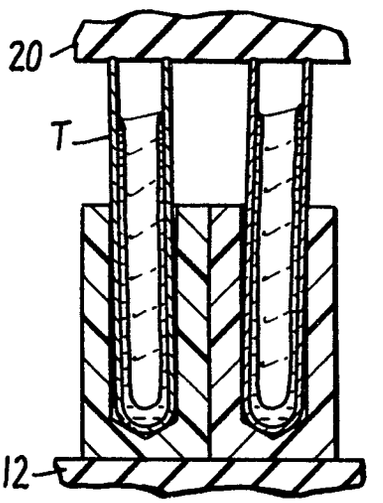


FIG .3.

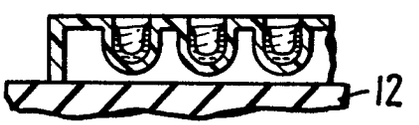


FIG .4.

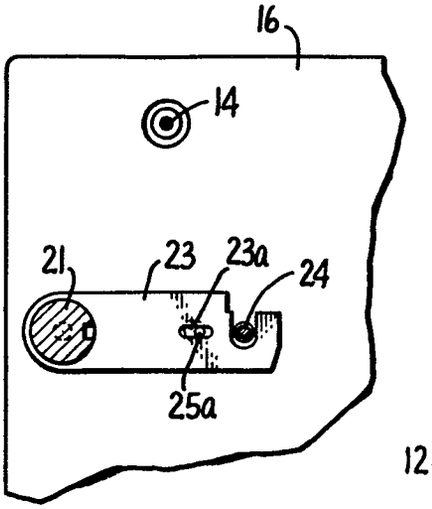


FIG .7.

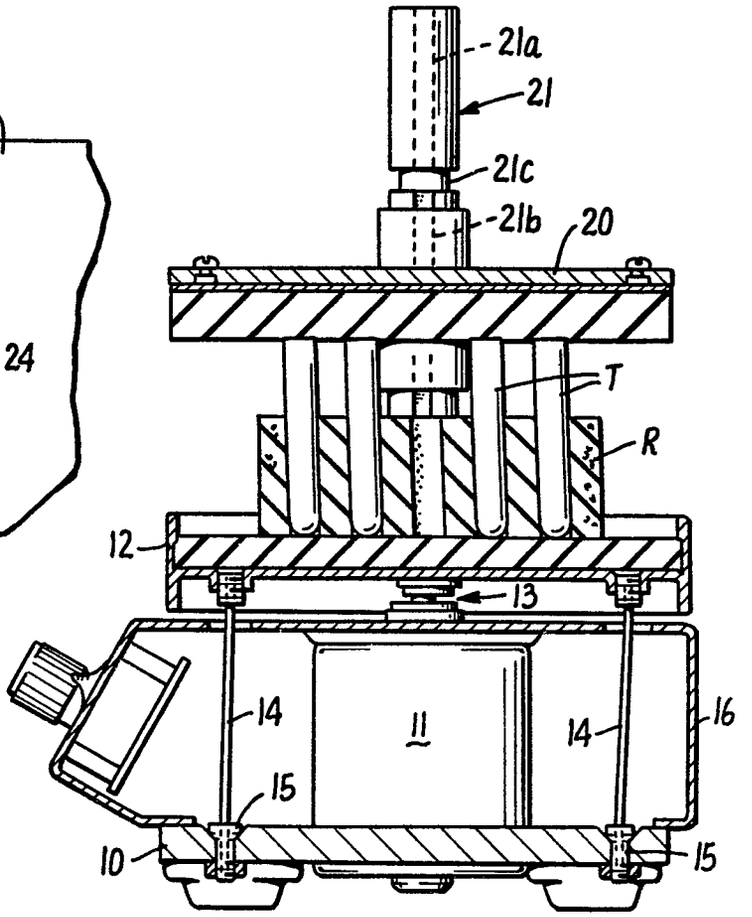


FIG .5.

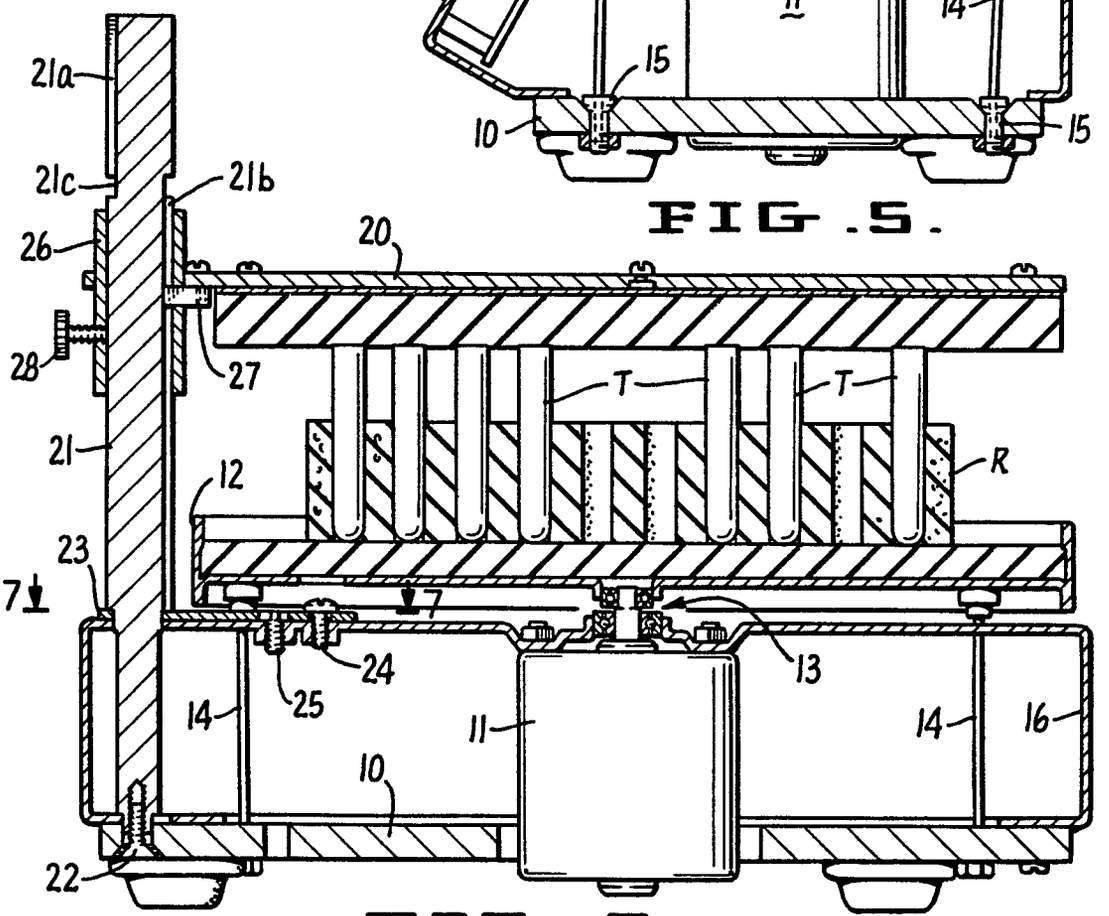
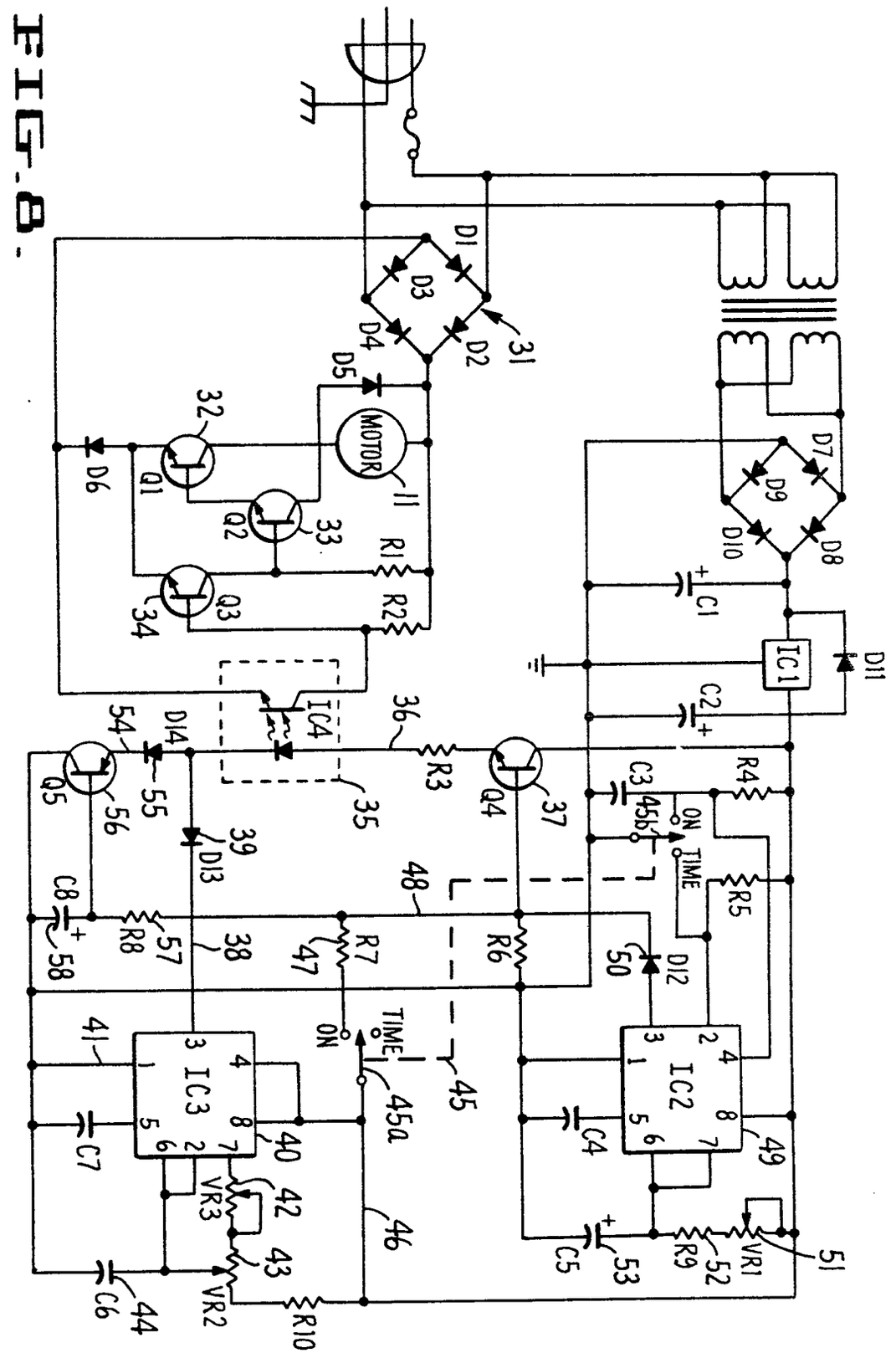


FIG .6.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D2
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D4
D5
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D7
D8
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D10
D11
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Q2
Q3
R1
R2
C1
C2
IC1
IC2
IC3
IC4
36
R3
Q4
37
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TIME
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R7
47
50
DI2
49
C4
C5
53
52
R9
VR1
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Q5
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C7
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VR3
42
43
VR2
C6
44
46
R10
45
45a
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FIG.8.