Later both of these odors seemed to disappear and a pulegone-like odor seemed dominant.

The small amount of oil precluded a chemical investigation. However, a few constants were determined. For the sake of comparison, these are herewith tabulated together with those of *Bystropogon origanifolius* and *B. mollis*.

	B. canus? Original oil.	Cohobated oil.	*B. origanifolius.*	*B. mollis.*
d	0.910 at 20°	0.980 at 20°	0.9248 at 15°	0.918 to 0.920
α_D	−0.59°		+2°57′	
n_D	1.563 at 25°	1.4623 at 25°	1.48229 at 20°	
A. V.	0	0	0	(abt. 0.7 p. c. free acids)
S. V.	183	135	11.1	

The amount of oil remaining was just sufficient to acquire some crude notion as to its boiling temperature, hence it was fractionated. Not more than two or three drops came over below 200°, hence terpenes were conspicuous by their absence. (Contrast the limonene content of *B. mollis.*) Three fractions of a few cc each were collected which, however, sufficed to determine their density. The last fraction had a delicate blue color, whereas the original oil had been somewhat olive-green. The residue was dark in color and its odor was indicative of decomposition. The boiling temperatures, etc., of the fractions are, herewith, tabulated:

Fraction.	B. temp.	Amt.	$d_{20°}$.
1	200 to 225°	2 ccm	0.9274
2	225 to 235°	2.5 ccm	0.9536
3	235 to 240°	5 ccm	0.9610

Menthol boils at 212° and has a density of 0.890 at 20°; pulegone boils at 222° and has a density of 0.9393 at 23°. However, neither the bisulphide test nor the nitroso test for pulegone gave positive results. Neither did exposure at low temperature cause any menthol to crystallize out. Likewise, Flueckiger's test for thymol and carvacrol gave negative results. It is apparant that larger amounts of material will be necessary to obtain more satisfactory information about the composition of this oil obtained from one of a seemingly interesting group of plants.

TEMPERATURE REGULATOR.*

For Automatically Controlling the Temperature of Water-Baths.

BY PAUL S. PITTENGER.

In two previous articles I described apparatus for maintaining temperatures above[1] and below[2] that of the ordinary room.

In the two forms described, the temperature was controlled by means of a toluol-mercury electric regulator operated by dry cells, the regulator serving to make and break the battery current to a relay which in turn either opened or closed the

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* Read before Scientific Section, A. Ph. A., New Orleans meeting, 1921.

[1] "An Improved Apparatus for Testing the Activity of Drugs on the Isolated Uterus," JOUR. A. PH. A., 7, 512, 1918.

[2] "A Constant Temperature Bath for Maintaining Temperatures Lower than That of the Room," *Ibid.*, 5, 1261, 1916.

110- or 220-volt circuit to an electric heater or a solenoid valve in an ice-water supply pipe.

The devices described were entirely satisfactory but required the periodic renewing of the dry cells. In an endeavor to eliminate this, experiments were made by replacing the toluol-mercury regulator, dry cells and relay, with a bimetallic electric thermoregulator. This worked fairly well with comparatively high temperatures but was not sensitive enough for temperatures lower than 40° C.

As we employ this form of apparatus principally for controlling constant temperature baths for biologic assay work it was necessary that the regulator be sensitive to a variation of 1 to 2° C. for temperatures between 22° C. (for frogs and gold fish) and C. 38° (for isolated uterus experiments).

It was therefore necessary to return to the toluol-mercury regulator. By carefully adjusting the size of the toluol bulb and the diameter of the mercury column, this regulator can be made sensitive to variations in temperature of less than 1° C.

We have finally overcome the annoyance of renewing the dry cells by replacing them with an electric "Toy Transformer" such as used for running toy electric trains under Christmas trees. These transformers can be purchased at almost any electric supply house and are so constructed that when attached to a 110-volt circuit, a range of from 1 to $27^1/_2$ volts may be obtained.

Briefly summed up, the new temperature regulating outfit is arranged as follows:

A toluol-mercury regulator is placed so the bulb dips into the water-bath. The toy transformer is then adjusted to 10 volts, connected with the regulator and a relay in such a way that the 110- or 220-volt current through the relay will heat an electric immersion heater or operate a solenoid water valve by which a cold water supply from a cooler may be either released or withheld.

When an experiment is to be conducted the tolucl-mercury regulator is adjusted to the temperature which we desire to maintain as described under Fig. 1, and as soon as the temperature of the water in the water-bath rises to this point, the toluol expands sufficiently to make an electrical contact which throws the relay, which in turn breaks the current to the electric heater or opens the solenoid valve which releases ice water from the cooler.

As the contents of the water-bath become cooler, the toluol in the regulator contracts and the 10-volt circuit through the relay is broken, thereby automatically turning on the current to the heater, or shutting off the supply of ice water until the temperature once more rises above that which we desire to maintain.

The following illustrations and explanations cover the arrangement of the new apparatus in detail.

Fig. 1 shows the construction of the *toluol-mercury regulator*. That portion of the glass tube which is lightly shaded (*1*) represents toluol. The black portion (*2*) represents mercury. The point of wire (*4*) is so arranged that it may be raised or lowered through stopper (*5*). Wire (*3*) is constantly in contact with mercury (*2*).

In order to adjust the regulator so that it will throw the relay at a given temperature, it is only necessary to place bulb *1* in a large beaker of water, or the water-bath, bring the temperature of the water to the exact temperature desired and then adjust battery wire *4* so that it just touches the surface of the mercury.

The regulator will then make a contact whenever the temperature of the bath rises to this point, and thus throw the relay.

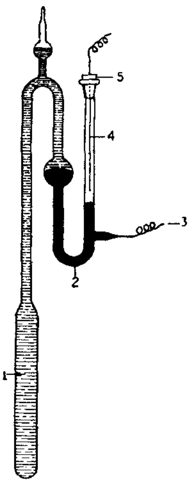

Fig. 1.—Toluol Mercury Regulator.

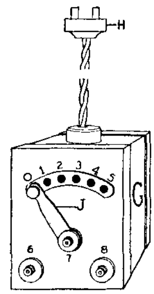

Fig. 2.—Toy Transformer.

Fig. 2 shows the *toy transformer* in which *H* represents an electric plug for attaching to 110- or 220-volt current; *J*, the lever switch; *1, 2, 3, 4* and *5* are the "points" of the rheostat controlling the voltage: *6, 7* and *8* are connecting posts.

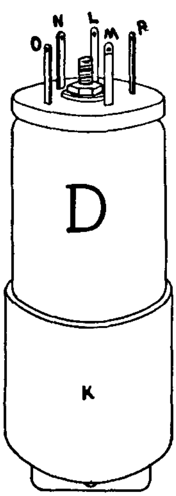

Fig. 3.—Relay.

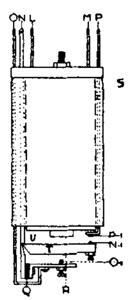

Fig. 4.—Relay with Cap *K* Removed.

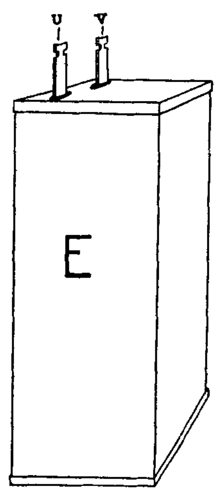

Fig. 5.—Condenser.

The following table shows the voltage obtained by the use of the switch and various connecting parts on the transformer illustrated:

Lever positions	0	1	2	3	4	5
Between 6 and 7	0	2½	5	7½	10	12½
Between 7 and 8	0	25	22½	20	17½	15
Between 6 and 8			27½ volts			

Figs. 3 and 4 illustrate the construction of the *relay*. *L* and *M* are the connecting posts attached to the terminals of the wire of coil *S* which surrounds the core *R*; *N*, *O* and *P* are the connecting posts for the wires carrying the 110- or 220-volt current and are connected directly with contact points *N-1*, *O-1* and *P-1*; *T* is an armature with a hinged joint at *U*; *Q*, insulating material.

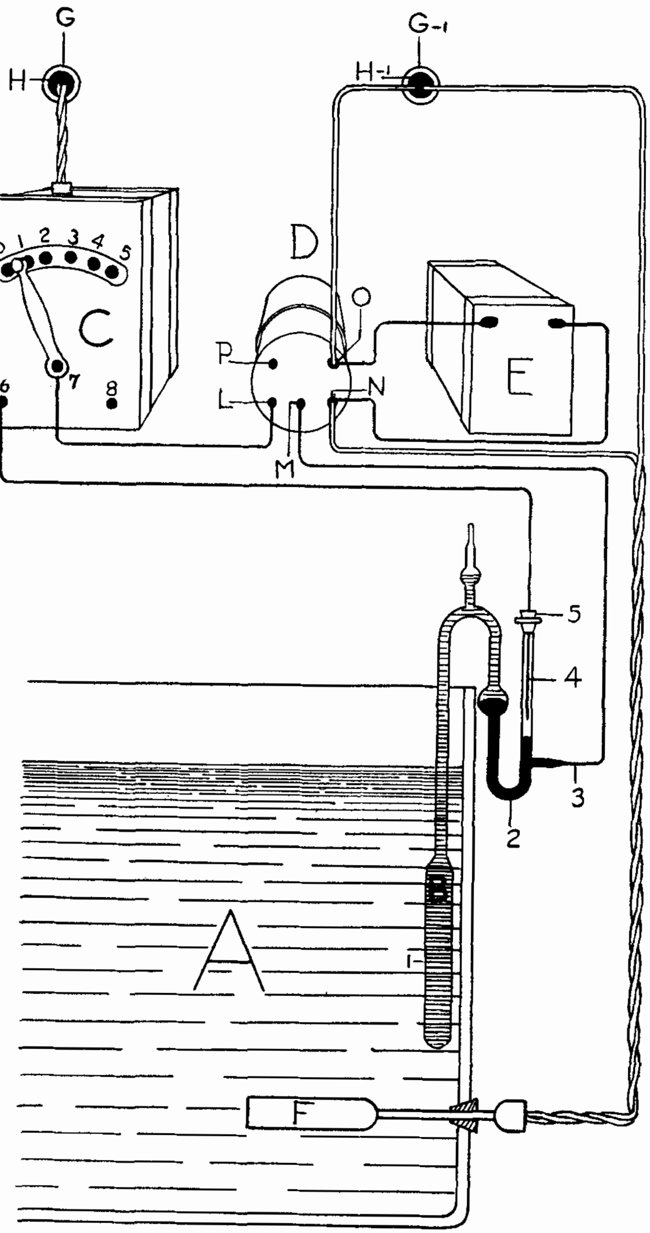

Fig. 6.—Method of Connecting Entire Apparatus.

When a current of about 10 volts is passed through coil *S* it makes an electromagnet of core *R*, thus raising the armature *T* and either breaking the contact between *O-1* and *T*, or making the contact between *N-1* and *P-1*. Thus the relay can be made to either make or break the 110- or 220-volt circuit depending upon which connecting posts are attached to the wires. If posts *O* and *N* are used, the relay will break the circuit by breaking contact *O-1* to *T*. If the posts *N* and *P* are used, the relay will complete the circuit by making contact *N-1* to *P-1*.

Fig. 5 shows the condenser. The two posts *U* and *V* are attached to wires connecting them with the same two posts of the relay to which the wires of the 110- or 220-volt circuit are attached. The purpose of the condenser is to reduce the "spark" in the relay and thus prevent the contacts *N-1*, *O-1* and *P-1* from burning off.

Fig. 6 shows the method of connecting entire apparatus. *A* represents the water-bath; *B*, toluol-mercury regulator; *C*, transformer; *D*, relay; *E*, condenser; *F*, electric immersion heater; *G* and *G-1*, electric sockets, 110- or 220-volt; *H* and *H-1*, electric plugs.

For maintaining temperature above that of the room, one wire from the electric heater *F* is attached directly to plug *H-1*, the other wire is attached to post *N* of the relay, and another wire connects post *O* with the plug *H-1*. By this arrangement, the current from the plug *H-1* passes uninterrupted through the relay contacts *O-1* to *I* to the heater *F*. The wire *4* of the regulator is attached to one "connecting post," *6*, of the transformer. The end of wire *3* is constantly in contact with the mercury, and the other end is connected to one "battery pole," *M*, of the relay. The other "battery pole" *L* of the relay is connected with the "connecting post" *7* of the transformer. As the temperature of the tank increases, the toluol in the regulator expands, causing the mercury to rise until it touches the end of wire *4*, thus completing the 10-volt circuit from the transformer and allowing the current to pass through the coil *S* around the core *R* of the relay. This forms an electromagnet which raises the armature *T*, thus breaking the contact *O-1* to *T* in the 110- or 220-volt circuit, and stopping the flow of electricity to heater *F*.

With the gradual lowering temperature of the water-bath, the toluol contracts and causes the mercury to fall away from wire *4* thus breaking the current which is passing through the coil of the relay. This break allows the armature to fall and again make contact *O–1* to *T*, and the current again passes from plug *H-1* to the electric heater.

If it is desired *to maintain a temperature lower than that of the room*, the 110- or 220-volt wires from the relay are connected with a solenoid valve in an ice-water supply pipe instead of the immersion heater and connecting posts *N* and *P* of the relay are used.

The entire apparatus only occupies about 4″ × 8″, and is especially useful for digestive ferment and biologic assays, or any experiment where a sensitive regulator is required.

PHARMACODYNAMIC LABORATORY,
H. K. MULFORD COMPANY.