555
TIMER
AND ITS APPLICATIONS

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555 TIMER
AND ITS APPLICATIONS

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CONTENTS

550 Timer

TIME ON YOUR HANDS ! With the monolithic integrated circuit 555 you can get accurate timing ranges of micro seconds to hours, independent of supply voltage variations. This versatile device has a large number of interesting practical applications, especially for electronic hobbyists.

Basically, the 555 timer is a highly stable integrated circuit capable of functioning as an accurate time-delay generator and as a free running multivibrator. When used as an oscillator the frequency and duty cycle are accurately controlled by only two external resistors and a capacitors. The circuit may be triggered and reset on falling wave forms. Its prominent features are summarized below :

* Timing from micro seconds through hours.
* Monostable and astable operation
* Adjustable duty cycle
* Ability to operate from a wide range of supply voltages.
* Output compatible with CMOS, DTL and TTL (when used with a 5 volt supply)
* High current output can sink or source 200 mA
* Trigger and reset inputs are logic compatible
* Output can be operated normal on and normal off
* High temperature stability

Let us see the make-up and operation of the 555 IC and see how the various features can be developed into practical circuits.

The 555 is available in 8-pin and 14-pin dual-in-line packages or in a circular TO-99 metal can with eight leads. Pin connec-

14-PIN DIP

TO-99

8-PIN DIP
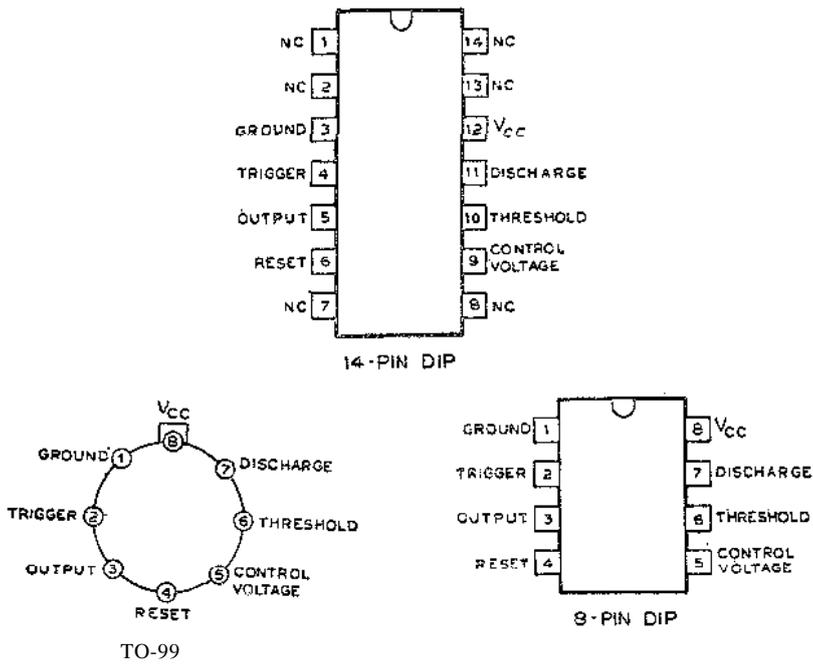
Fig. 1. Pin Connections For The 555 Timer. (TOP-VIEWS)

tions for various packages are shown in Fig. I. The SE and NE versions are similar except for maximum temperature ratings. The precision type SE maintains its essential characteristics over a temperature range of —55° C to +125° C while the general purpose type NE operates reliably only over a range of 0° C to 70°C. Some manufactures use the suffix C to indicate the commercial version for general purpose applications. Both types have a maximum rating of 18 volts and can handle power dissipation of upto 600 mW.

The 556 is a dual timer which is basically two 555's in a single package.

Comprising of 23 transistors, 2 diodes and 16 resistors, (fig. 2} the 555 has built-in compensation for component tolerance

and temperature drift resulting in a temperature coefficient of only 25 parts per million per degree Centigrade.
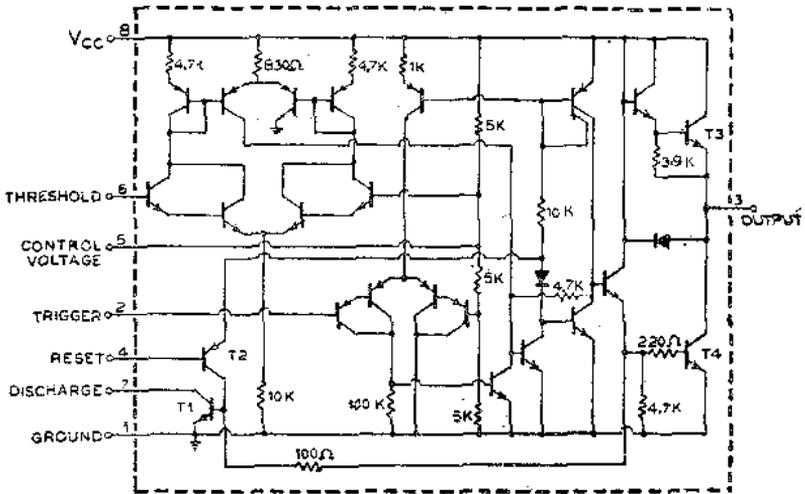
Fig. 2. 555 Timer Schematic Diagram.
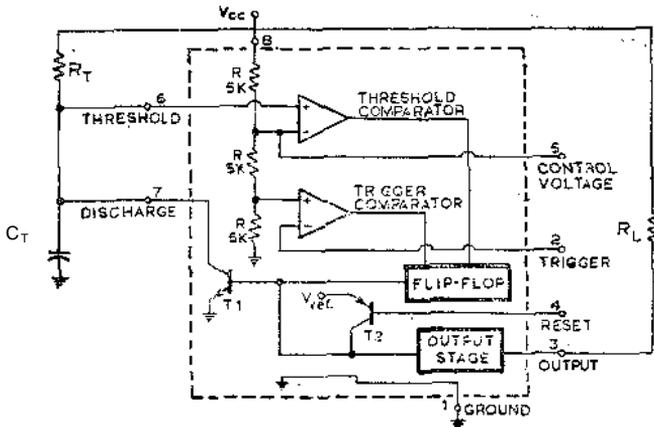
Fig. 3. Functional Block Diagram.

OPERATION

A functional block diagram of timer is shown in Fig, 3.   The

device consists of two comparators*, two control transistors, a flip-flop and a buffered output stage. The reference/Voltages for the two comparators inside the 555 are developed across a voltage divider consisting of three equal resistors R of 5K ohms each. The threshold comparator is referenced at 2/3 V_{cc} and the trigger comparator is referenced at 1/3 Vcc. The two comparators control the flip-flop, which, in turn controls the state of the output. When the timer is in the quiescent state, the internal transistor T_I is conducting and represents a short circuit across timing capacitor C_T.. The level of the output terminal is low.

In most practical circuits, the-voltage on pin. 2 is held above the trigger point by a resistor connected to V_{cc}. When a negative-going trigger pulse on pin 2 causes the potential at this point to fall below 1/3 *Vcc,* the trigger comparator switches the flip-flop, cutting off T_1 and forcing the output level high to a value slightly below *Vcc-* Capacitor C_T now starts to charge and the voltage across it rises exponentially until it reaches 2/3 *Vcc-* At this point, the threshold comparator resets the flip-flop and the output returns to
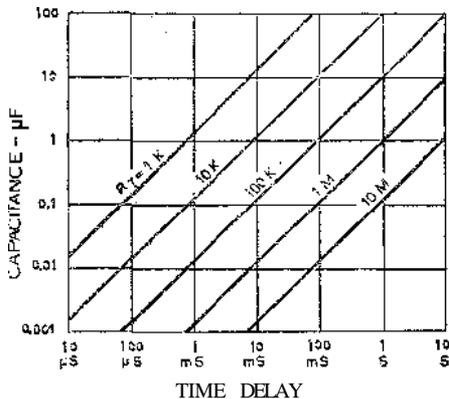
Fig. 4. Delay Times For Different Values Of Resistors And Capacitors

* A comparator is an op-amp that compares an input voltage and indicates weather the input is higher or lower than the reference voltage, when the input swings slightly above the reference value, the op-amp's output swings into saturation. At the instant the input drops below The reference level, the op-amp's output swings into reverse saturation. The output changes state when the input rises above or drops below the reference voltage level by only a few hundred microvolts.

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its low state-just slightly above ground. Transistor T_1 is turned ON, discharging C_T so that it is ready for the next timing period. Once triggered, the circuit cannot respond to additional triggering until the timed interval has elapsed.

The delay period—the time that the output is high—in *seconds* is 1.1 R_T C_T, where R_T is in *ohms* and C_T in *farads.* Figure 4 shows how delays running from 10 micro seconds to 10 seconds can be obtained by selecting appropriate values of C_T and R_T in the .001 mF to 100 mF and 1 K to 10 megohms ranges. In practice R_T should not exceed 20 megohms. When you use an electro¬ lytic capacitor for C_T, select a unit for low leakage. The time delay may have to be adjusted by varying the value of R_T to com¬ pensate for the very wide tolerance of electrolytics.

An important feature to be noted here is that 555, unlike many RC timers, provides a timed interval that is virtually inde- pendent of supply voltage *Vcc.* This is because the charge rate of C_T and the reference voltages to the threshold comparator and trigger comparator are all directly proportional to the supply voltage. Operating voltage can range from 4.5 volts to a maxi- mum of 18 volts.

Feeding the Load

We have seen how the timed interval or delay is obtained. Now let us see how we can use it. A look at the output circuit (T_3 and T_4 in Fig. 2) shows it to be a quasi complementary trans- formerless arrangement similar to many audio output stages. Furthermore, we know that in this type of circuit, one side of the load goes to the emitter-collector junction of the output transis- tors and the other side of the load can be connected to 'Vcc or to ground. The same applies to the load connected to the 555. Output pulses developed across load R_L can be obtained directly from pin 3.

When the load is collected to V_{CC}, a considerable amount of current flows through the load into terminal 3 when the output

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is low. Similarly when the output is high, the current through the load is quite small. Conditions are reversed when the load is returned to ground. In this case, output current through the load is maximum when the output potential is high and minimum when the output is low. The maximum current at terminal 3 is 200 mA when it is used as a current source or current sink.

Driving a Relay

A relay can be substituted for R_L in applications where the delay or timed interval is longer than 0.1 second. The relay should be a DC type with a coil operating at about *Vcc* and not drawing more than 200 mA. Figure 5 shows a simple manual timer with the two optional connections for the relay.
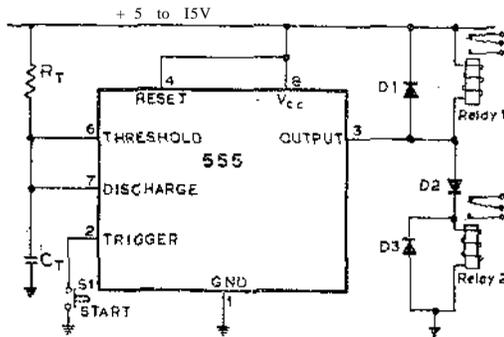
Fig, 5. Relay Timer Showing Two Optional Connections.

You must be careful when connecting an inductive load such as a relay to the output of the 555 or any other solid-state device. When the current through an inductive load is interrupted, the collapsing magnetic field generates a high reverse emf (transient voltage) that can damage the device. The solution to this problem is to connect a diode (D1 or D3) across the relay coil so that it conducts and absorbs the transient. Note that the diode must be connected so it is reverse biased in normal operation.

Diode D2 must be inserted in *series* with the relay coil when it is connected between the output terminal and ground. Other-

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wise, a voltage equal to one diode-junction drop will appear at pin 3 and may cause the timer to latch up.

Triggering

As staled earlier, in most practical circuits, the trigger terminal is generally returned to *Vcc* through a resistor of about 22kW. However, the simplest method of triggering a 555 is to *momentarily* ground the terminal. This is OK as long as the ground is removed before the end of the timed interval. Thus, if the device is used in a photo-timer application, as in Fig. 5, tapping push button SI is sufficient to trigger the circuit and start the timer.

In many applications, the 555 must be triggered by a pulse. The amplitude and minimum pulse width required for triggering are dependent on temperature and supply voltage. Generally, the current required for triggering is about 0.5 *mA* for a period of 0.1 m*s*. Triggering-voltage ranges from 1.67 volts when V_{CC} is 5 volts to 5 volts when V_{CC} is 15 volts.

The triggering circuit is quite sensitive and can be activated by simply touching the terminal with a finger or bringing your hand close to a length of wire fastened to pin 2.

Resetting

Once a timed cycle has been initiated by a negative-going pulse on pin *2,* the circuit is immune to further trigger until the cycle has been completed. However, the timed cycle can be inter¬ rupted by grounding the reset terminal (pin 4} or applying a negative-going reset pulse to it. The reset pulse causes timing capacitor C1 to be discharged and the output to return to its quiescent low state. Reset voltage is typically 0.7 volt and reset current is 0.1 mA. When the reset terminal is not being used, it should be connected to V_{CC}.

The Control Terminal

The 2/3 V_{CC} point on the internal voltage divider Is brought out to pin 5—the control terminal. The timing cycle can be modified

by applying a DC control voltage to pin 5. This permits manual or electronic remote control of the timed interval.

The control terminal is seldom used when the timer is operated in the monstable mode and should be grounded through a 0.01 mF capacitor to prevent the timed interval from being affected by pickup of a stray AC or RF signal.

When the timer is operated as an oscillator in the astable mode, the generated signal can be frequency modulated or pulse-width modulated by applying a variable DC control voltage to pin 5.

Monostable Operation

In this mode of operations the timer acts as a one shot. Details of the external connections and the wave-forms are shown in Fig. 6. The external timing capacitor C_T is held initially discharged by the transistor (T1 in Fig. 2) inside the timer. Upon application of a negative pulse to pin 2, the flip-flop is set which releases the short circuit across the external capacitor and drives the output high. The voltage across the capacitor, now, rises exponentially with the time constant $RT\ CT$. When the voltage across the capacitor equals $2/3\ V_{cc}$, the threshold comparator resets the flip-flop which, in turn, discharges the capacitor rapidly and drives the output to its low state. The circuit rests in this state till the arrival of next pulse.
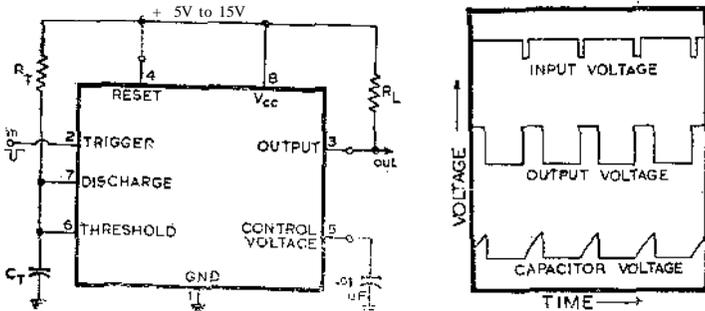

Fig. 6. Monostable Hookup For 555

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The circuit triggers on a negative going input signal when the level reaches $\frac{1}{3}$ V_{CC}. Once triggered the circuit will remain in this state until the set time is elapsed, even if it is triggered again during this interval. The time that the output is in the high state is given by $t = 1.1$ $R_T C_T$. Applying a negative pulse simultaneously to the reset terminal (pin 4) and the trigger terminal (pin 2) during the timing cycle discharges the external capacitor C_T and causes the cycle to start over again. The timing cycle will now commence on the positive edge of the reset pulse. During the time the reset pulse is applied, the output is driven to its low state. When the reset function is not in use, it is recommended that it be connected to V_{CC} to avoid any possibility of false triggering.

Astable Operation

If the circuit is connected as shown in Fig. 7, it will trigger itself and free run as a multi-vibrator. The external capacitor charges through R_A and R_B and discharges through R_B only. Thus the duty cycle may be set precisely by the ratio of these two resistors.

$$t_1 = 0.693(R_A + R_B).C_T$$

$$t_2 = 0.693(R_B).C_T$$

$$T = 0.693(R_A + 2R_B).C_T$$

$$f = \frac{1}{T} = \frac{1.44}{(R_A + 2R_B)C_T}$$
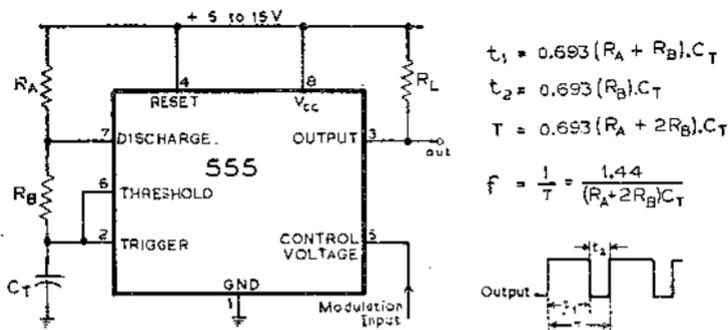
Fig. 7. Astable Operation Of 555 Timer.

In this mode of operation, the capacitor charges and discharges between $\frac{1}{3}$ V_{CC} and $\frac{2}{3}$ V_{CC}. As in the triggered mode, the charge and discharge times and hence the frequency is independent of the supply voltage.

The charge time (output high) is given by:

$$t_1 = 0.693 \ (R_A + R_B) \ C_T$$

The discharge time (output low) is given by :

$$t_2 = 0.693 \ (R_B) \ C_T$$

Thus the total period T is given by :

$$T = t_1 + t_2 = 0.693 \ (R_A + 2 \ R_B) \ C_T$$

and the frequency of oscillation is then :

$$f = \frac{1}{T} = \frac{1.44}{(R_A + 2 \ R_B)} C_T$$

This may be easily found by figure 8 graph.
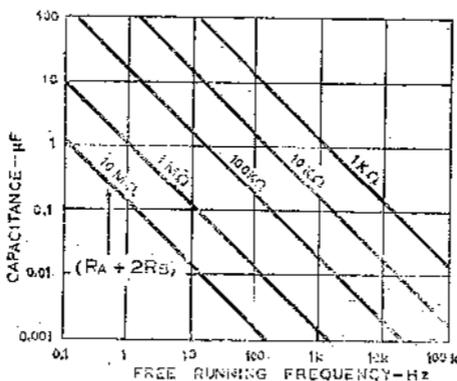
Fig. 8. Free Running Frequency Of Astable Multivibrator.

The duty cycle is given by $D = \dfrac{R_B}{(R_A + 2 \ R_B)}$

From the above equation, it will be seen that the frequency and the duty cycle are inter-dependent and change of value of R_A or R_B affects both. It is possible to have a completely independent control of the charge and discharge times by using two external diodes as shown in Fig. 9. The timing capacitor C1 charges through D1 and R1 and discharges through D2 and R2. A modified arrangement shown separately at left in Fig. 9 provides a control over duty cycle without changing the output pulse frequency. The diode voltage drops, however, make the time more sensitive to supply voltage variations.

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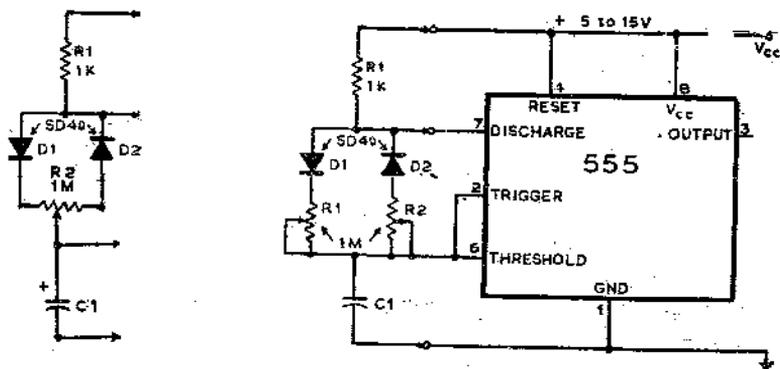
Fig. 9. Independent Control Of Charge And Discharge Timings.

Bistable Operation.

The 555 timer can also function as a bistable flip-flop in such applications as TTL compatible drivers. This flip-flop offers the advantage that it operates from many different supply voltages, uses little power and requires no external components other than bypass capacitors in noisy environments. It also provides a direct relay driving capability.
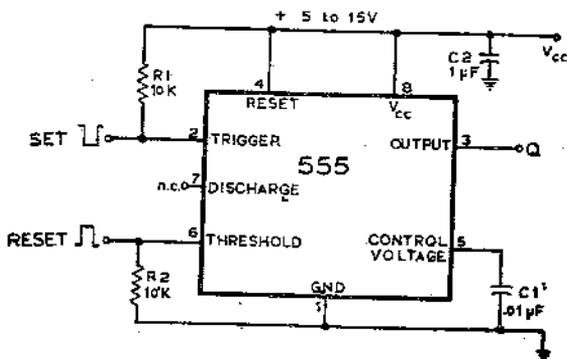
Fig. 10. 555 Timer Operated As A Flip Flop.

As shown in Fig. 10, a negative pulse applied to the trigger input terminal (Pin2) sets the flip flop and the output Q goes high. A positive going pulse applied to threshold terminal will reset the

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flip-flop and drive the Q output low. The flip-flop can also be reset by applying a negative going pulse to the reset terminal (Pin 4). In this mode Pin 6 is kept low.

Schmitt Trigger

Apart from timing functions, the two comparators of the 555 timer can be used independently for other applications. One example is a schmitt trigger shown in Fig. 11. The two comparator inputs (Pin 2 and 6) are tied together and biased at $\frac{1}{2}$ V_{CC} through a voltage divider R1 and R2. Since the threshold comparator will trip at $\frac{2}{3}$ V_{CC} and the trigger comparator will trip at $\frac{1}{3}$ V_{CC}, the bias provided by the resistors R1 and R2 is centred within the comparators' trip limits.
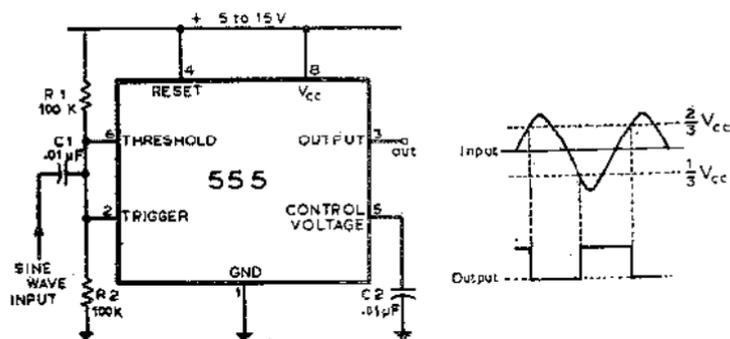
Fig. 11. 555 Timer As A Schmitt Trigger.

A sine wave input of sufficient amplitude to exceed the reference levels causes the internal flip-flop to be set and reset. In this way, it creates a square wave at the output. So long as R1 is equal to R2; the 555 will be automatically biased correctly for almost any supply voltage. The output waveform is 180° out of phase with the applied sine wave. The circuit can be used as a signal shaper/buffer with advantage of availability of high output current.

By modifying the input time constant of the circuit shown in Fig. 11 (e.g., reducing the value of input capacitor to .001 μF) so that the input pulses get differentiated, the arrangement can also

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be used either as a bistable device or to invert pulse waveforms. In the later case, the fast time constant of the combination of C1 with R1 and R2 causes only the edges of the input pulse or rectangualr waveform to be passed. These pulses set and reset the flip-flop and a high level inverted output is the result.

Square Wave Oscillator

A conventional astable circuit using a 555 IC does not normally produce a symmetrical output waveform (Fig. 7). Square waves can be obtained by circuit shown in Fig. 12.
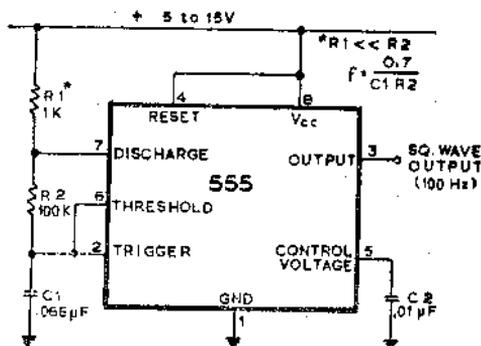
Fig. 12. Square Wave Generator.

The assymetry of a conventional astable circuit is a result of the fact that charging and discharging times are not equal. In Fig. 12, capacitor C1 is charged through R1 and R2 while discharged through R2. If R1 is made very small compared to R2, the both time constant will be reduced so that they essentially depend on R2 and C1. The frequency of operation (f) is approximately $\dfrac{0.7}{R_2\,C_1}$. The frequency is of course independent to the supply voltage.

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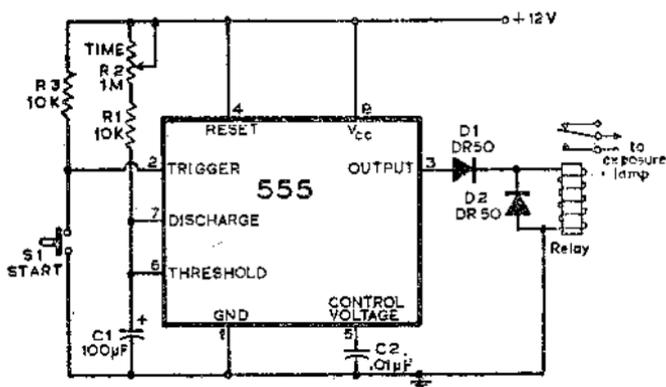
Photo Timer

Fig. 13. Photo Timer

The circuit shown in Fig. 13 is useful for providing controlled 'on' times for such equipment as photo-enlargers, developers, small heaters, incandescent lamps, etc. Time is set by potmeter R2 which provides a range of 1 sec. to 100 second with timing capacitor C1 of 100 μF.

The output at pin 3 is normally low and the relay is held off. A momentary touch on switch S1 energises the relay which is held closed for a time 1.1 × (R1 + R2). C1 and then released. The exact length of the timing interval will depend on the actual capacitance of C1. Most electrolytic capacitors are rated on the basis of minimum guaranteed value and the actual value may be higher. The circuit should be calibrated for various positions of the control knob of R2 after the timing capacitor has had a chance to age. Once the capacitor has reached its stable value, the timings provided should be well within the photographic requirements.

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Parts List

C_1	...	100 μF 12V electrolytic
C_2	...	.01 μF disc ceramic
D_1, D_2	...	DR 50 or 1N 4001
R_1, R_2	...	10 kΩ, $\frac{1}{4}$W
R_3	...	1 MΩ, potmeter
Relay	...	12V, DC relay, operating current less them 200 mA
S_1	...	Push-to-on switch
Timer	...	555 IC.

Touch Plate Controller
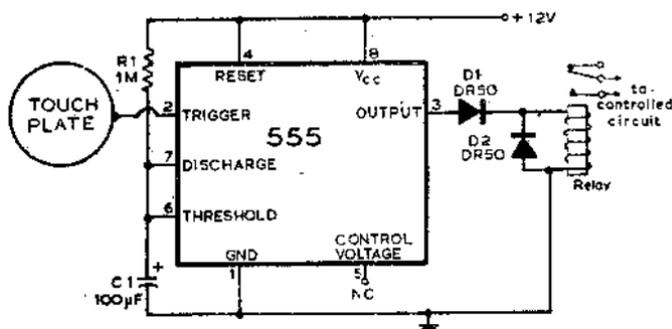
Fig. 14. Touch Controlled Relay.

Touch the small metal plate and the relay gets energised, kept on for about 100 seconds and then released. Such circuits are ideally suited for making touch-operated call-bells, buzzers or small toys which, once touched, operate for a small time and then switch off automatically.

The input impedance of the trigger comparator of 555 is very high and the circuit can be triggered by the voltage induced in a human body. This fact is used in making the touch switch shown in Fig. 14. Toy motors can be driven directly by deleting the diodes D1, D2 and the relay and driving a power transistor like AC 128 directly (See Fig. 15) from the output pin 3 of the IC.

Parts List

C_1	100 µF 12V, electrolytic
D_1, D_2	DR 50 or 1N 4001
R_1	1 MΩ ¼W
Relay	12V dc relay, operating current less then 200 mA.
Timer	555 IC

Auto Wiper Control
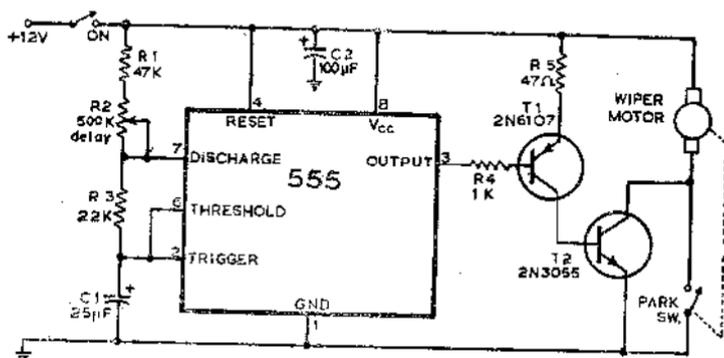
Fig. 15. Delayed Auto-Wiper Cycle Timer

A continuously working wiper is a big nuisance when it is not raining hard. The wiper control shown in Fig. 15 allows the wiper to sweep at rates varying from once a second to once in 10 second

Basically the circuit is an astable multivibrator, (See Fig. 7) in which the output level at pin 3 remains high for a long time decided by R2 and low for a short time decided by R3. The low going output at pin 3 drives the wiper motor via T1 and T2 for a time just sufficient to operate the parking switch. The wipers then make one sweep and rest again in their normal parked position till the next pulse. Resistor R5 limits the current and power dissipation in T1. Transistors T1 and T2 may be replaced by a relay if desired.

Parts List

C_1	25 µF, 12V, electrolytic		
C_2	100 µF, 25V electrolytic		
R_1	47 kΩ, ¼W	R_5	47 Ω, 3W
R_2	500 kΩ potmeter	T_1	2N 6107
R_3	22 kΩ, ¼W	T_2	2N 3055
R_4	1k Ω, ¼W	Timer	555 IC

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Automatic Headlight Turn-Off

Any one who has stumbled around in a dark garage after leaving his car for the night will appreciate this automatic headlight shut off switch. The switch, when installed in a car automatically turns off the headlights at predetermined period after the ignition is switched off.
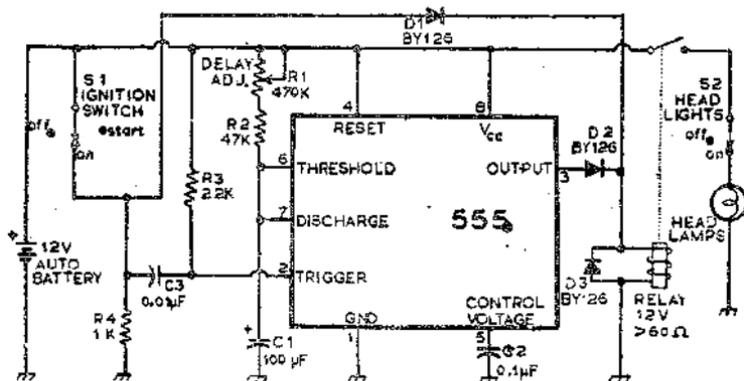
Fig. 15(A). Automatic Headlights Turnoff

In Fig. 15(A) when the igintion is first switched on, the battery voltage is fed to the relay coil through diode D1. Switching off the ignition generates a negative-going pulse on pin 2 that triggers the timer. The output of the IC goes high to energise the relay and keep the headlights on long enough for you to leave the garage. With the values shown the delay is adjustable from approx. 10 seconds to 1 minute.

Parts List

C₁	100 µF 12V		
C₂	0.1 µF Ceramic		
C₃	0.01 µF Ceramic		
D₁, D₂, D₃	By 126	R₄	1K 1W
R₁	470K Potmeter	Relay	12V, dc, operating
R₂	47K ¼W		Current less then 200 mA
R₃	22K ¼W	Timer	555

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Tiny Flasher
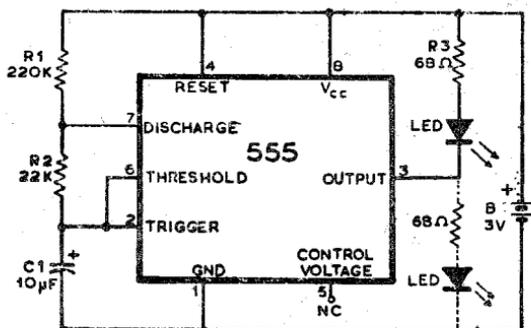
Fig. 16. LED Flasher

A small size LED flasher operating on self contained batteries may be useful as a flashing metronome, dark room timer, memo-reminder and similar applications. The circuit of Fig. 16 is an astable multivibrator with a duty cycle of about 10%. LED connected as shown in the figure will be on for a short period and off for a longer period. The duty cycle will be reversed if R3 and the LED are connected as shown dotted in the figure and the battery consumption will also increase proportionally.

Parts List

B	..	Battery 3V, pen light cells.
C_1	..	10 μF 6V electrolytic
LED	..	Light Emitting Diode
R_1	..	220 kΩ, $\frac{1}{4}$W
R_2	..	22 kΩ, $\frac{1}{4}$W
R_3	..	68Ω, $\frac{1}{4}$W
Timer	..	555 IC.

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Solid State Flasher
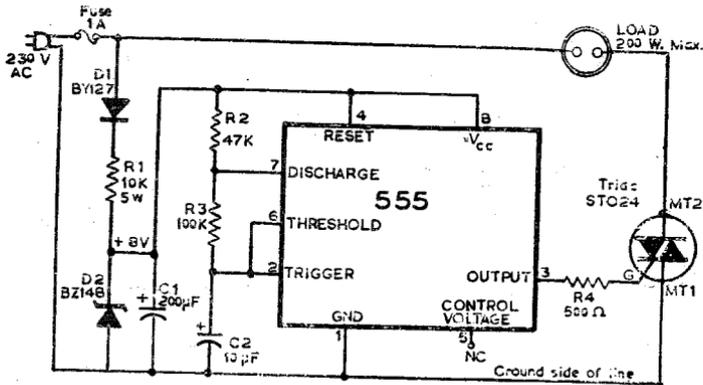
Fig. 17. Solid State Flasher

The mains operated flasher shown in fig. 17 uses a 555 timer to control the ON and OFF times of a triac which controls power to the load. The power supply for the IC is obtained by half wave rectifier and a stabilizer circuit comprising of rectifier diode D1, zener diode D2, resistor R1 and filter capacitor C1. The lamp in the load circuit remains on for about 1 second and for about 0.7 seconds. Other timings may be obtained by choosing appropriate R2, and R3.

Parts List

C_1	200 µF 12V electrolytic
C_2	10 µF 12V electrolytic
D_1	BY 126 or BY 127
D_2	BZ 148
R_1	10 kΩ, 5W
R_2	47 kΩ, ¼W
R_3	100 kΩ, ¼W
R_4	500Ω, ¼W
Triac	STO 24
Timer	555 IC

Sense-of-Time Tester
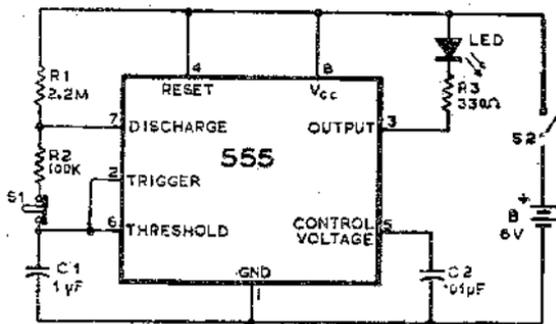
Fig. 18. Personal Sense-of-Time Tester

How accurate is your sense of time ? You can find it out for yourself by catching a flashing LED.

When S2 is on, the circuit in Fig 17 operates as an astable multivibrator (See Fig. 7) and the LED is lit for about 0.1 sec. flashing every 1.5 seconds. Since the human reaction time is more then this, you cannot catch it once it is seen on, by pressing S1. If your sense of time interval is good, and you press S1 within that 0.1 Sec., the discharging of C1 stops and the lamp stays lit. You may change the ON and OFF periods by changing R1 and R2 or C1 to suit your convenience.

Parts List

B	Battery 6V
C_1	1 μF 6V electrolytic
C_2	.01 μF disc ceramic
LED	Light emitting diode
R_1	2.2 MΩ, $\frac{1}{4}$W
R_2	100 kΩ, $\frac{1}{4}$W
R_3	330Ω, $\frac{1}{4}$W
S_1	Push-to-off switch
Timer	555 IC

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Square Wave Generator
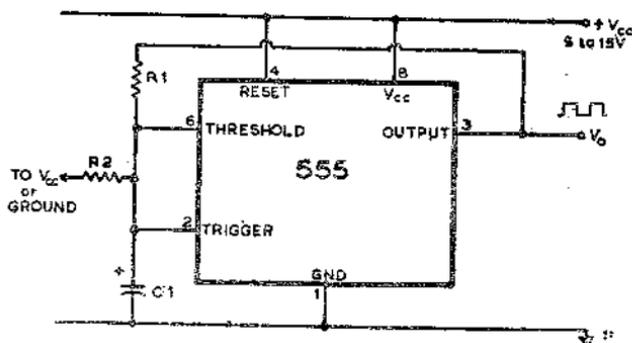
Fig. 19. Square Wave Generator

With only one external resistor and one capacitor a 555 timer IC can be made to generate fairly accurate square waves.

The square wave generator circuit shown in fig. 19 makes use of the fact that output voltage in a 555 IC is 180° out of phase with the capacitor voltage. To understand the circuit operation let us assume a state when output is high and the capacitor C1 is charging via R1. When the voltage across capacitor reaches 2/3 Vcc the output goes low and C1 now starts discharging through R1. When the voltage across C1 falls to $\frac{1}{3}$ Vcc the circuit trips again, output goes high, the capacitor starts charging and the cycle repeats endlessly. Since charging and discharging takes through R1 only, the output is a symmetrical square wave. The period of oscillator is given by T=1.4 RC

The output symmetry depends on the accuracy of the timer's internal resistor string which produces the IC's comparator reference voltages. These errors can be eliminated by adding a trimming resistor R2 and connecting it to supply line or ground depending on the correction needed.

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Linear Saw Tooth Generator
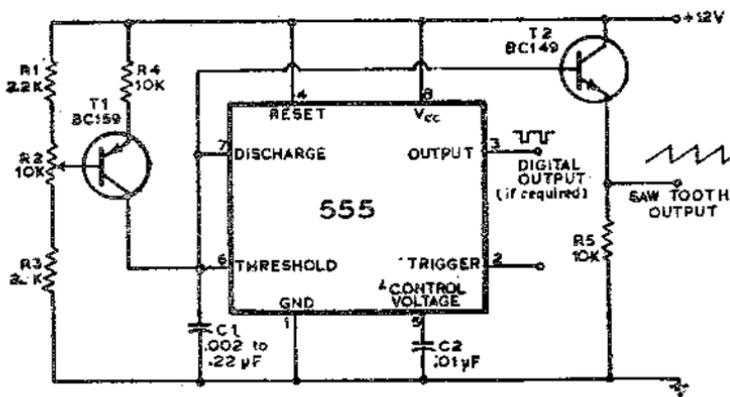
Fig. 20. Sawtooth Generator Using Current Source

The voltage across the timing capacitor C_T in the monostables multivibrator circuit of fig. 6 rises to $\frac{2}{3}$ V_{CC} and then drops to almost zero. A sawtooth waveform is, therefore, available across this capacitor, but is not linear because the capacitor voltage rises exponentially. In fig. 20 the capacitor is allowed to charge via a constant current source comprising of T1, R1, R2, R3 and R4. The voltage now rises linearly and the output is taken via an emitter follower buffer stage T2 to isolate the load from the timing circuit. For use as a scope time base, a trigger signal may be applied to terminal 2 of the IC.

Another arrangement by which a linear sawtooth can be produced is by bootstrapping the output as shown in fig. 21 Capacitor C1 begins to charge through R1, R2, and R3 towards V_{CC}. The voltage across R5 at the output of emitter follower T1 is almost same as that at pin 7 of the IC. This voltage is fed back to junction of R1 and R2. As a result, the voltage across R2 remains essentially constant during C1's charging cycle and the

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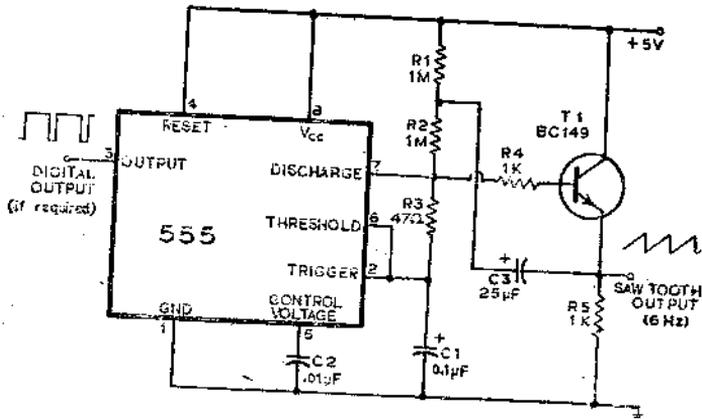
Fig. 21. Sawtooth Generator Using Boot-Strap Circuit

capacitor voltage rises linearly. Connecting pin 2 to pin 6 causes the circuit to trigger itself and free run as an astable multivibrator. Alternatively, the synchronizing signal may be applied to pin 2.

Resistor R3 is required to slow down the negative discharge slope of the saw tooth. $R3 \times C1$ is kept greater than 5 microseconds.

Parts List

Component	Fig. 20	Fig. 21
C_1	.002 to 0.22μF mylar	.002 to 0.22 μF mylar
C_2	.01 μF ceramic	.01 μF ceramic
C_3	—	25μF 6V
R_1	2.2 k Ω $\frac{1}{4}$W	1M Ω $\frac{1}{4}$W
R_2	10 K Ω potmeter	1 M Ω $\frac{1}{4}$W
R_3	22k Ω $\frac{1}{4}$W	47 Ω $\frac{1}{4}$W
R_4	10K Ω $\frac{1}{4}$W	1k Ω $\frac{1}{4}$W
R_5	10 k Ω $\frac{1}{4}$W	1k Ω $\frac{1}{4}$W
T_1	BC 159	BC 149
T_2	BC 149	—
Timer	555 IC	555 IC.

# Warble Tone Generator
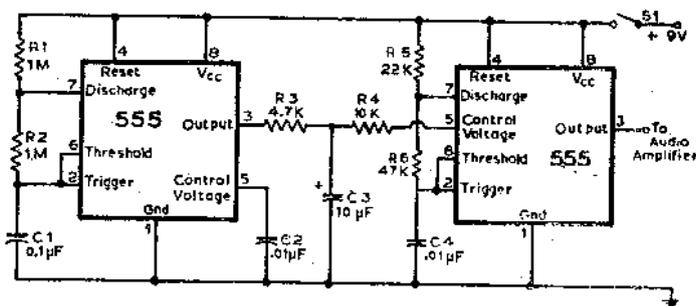
Fig. 22. Warble Tone Generator

The tone generator described here is an audio attention generator. Such circuits may be used for alarm sirens or for producing unique tones in cable testing, which will not get mixed up with other noises.

In the schematic shown in fig. 22 the first 555 oscillates below 10 Hz. Its rectangular output is filtered by filter R3, R4 and C3 to produce traingular waves which modulate the 1KHz oscillator using the second 555 in astable mode. The exact frequency, rate, and deviation of the circuit can be easily modified to produce almost any type of warble sound. The output may be amplified by an audio amplifier to the required power level.

Parts List

C_1	0.1 μF, ceramic
C_2, C_4	0.01 μF, ceramic
C_3	10 μF, 12V, electrolytic
R_1, R_2	1M Ω, $\frac{1}{4}$ W
R_3	4.7kΩ, $\frac{1}{4}$ W
R_4	10k Ω, $\frac{1}{4}$ W
R_5	22k Ω, $\frac{1}{4}$ W
R_6	47k Ω, $\frac{1}{4}$ W
S_1	ON/OFF switch
Timer	555 IC two nos. (or one 556)

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Delayed Automatic Power Off
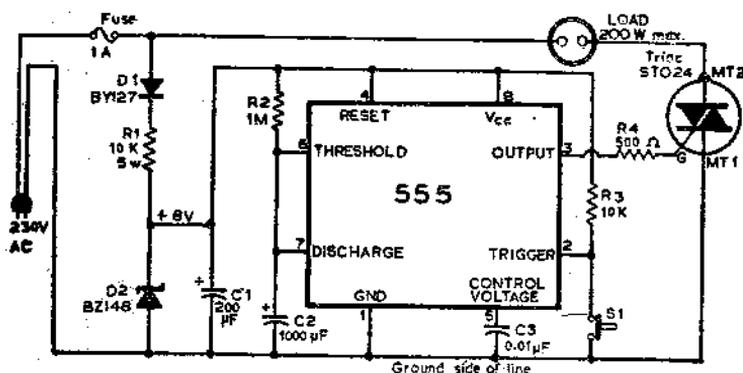
Fig. 23. Circuit Turns Off Power After Delay.

This circuit will automatically turn off power to your stereo player or radio after about 20 minutes. You can also use such circuits to put off porch light after you lock the house and move out and similar other uses.

The 555 timer operated as a monostable (Fig. 6). A momentary push on S1 makes the output go high which triggers the triac and makes power available in the socket. The IC output goes low again when C2 has charged upto ⅔ of the supply voltage which, because of large value of C2 takes about 20 minutes. Capacitor C2 should have low leakage otherwise it will charge very slowly and in cases of excessive leakages may not charge to full value at all. Power supply for the timer is provided by half wave rectifier D1, voltage dropping resistor R1, zener diode D2 and filter capacitor C1.

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Parts List

|		
C_1	...	200 μF 12V electrolytic
C_2	...	1000 μF, electrolytic 12V (see text)
C_3	...	0.01 μF disc ceramic
D_1	...	BY 126 or BY 127
D_2	...	BZ 148
Fuse	...	1 Amp.
R_1	...	10 k Ω 5W
R_2	...	1M Ω ½W
R_3	...	10k Ω ½W
R_4	...	500 Ω ¼W
S_1	...	Push-to-On switch.
Timer	...	555 IC
Triac	...	ST 024.

Delayed Automatic Power On
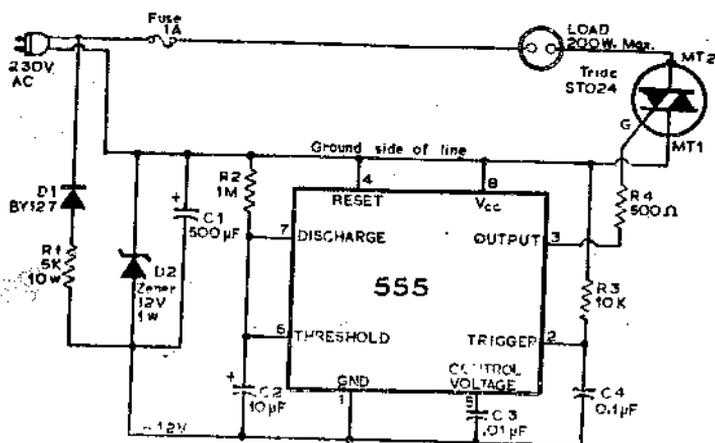
Fig. 24. Circuit Turns Power On After Delay

The circuit shown in fig 24 will turn power ON to the load after a pre-determined delay, about 10 seconds in this case. It might be used to delay the application of power to a fuel pump or start the blower of an air-conditioner before the compressor and similar applications

The circuit again uses a triac as in fig. 23 and utilizes the fact that triac can be switched on by a negative bias also. Capacitor C2 starts charging from the instant the plug is put into power socket. When C2 is charged to $\frac{2}{3}$ Vcc the out put goes low and the negative voltage triggers the triac energizing the load. A triac needs larger amount of power in this mode of triggering and R1 has therefore been reduced to give more power available in the timer supply.

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Parts List

C_1	500 µF, 25V, electrolytic
C_2	10 µF, 12V electrolytic
C_3	0.01 µF, Ceramic
C_4	0.1 µF Ceramic
D_1	By 126 or By 127
D_2	1Z 12
Fuse	1 Amp.
R_1	5K 10 W
R_2	1 M, $\frac{1}{4}$ W
R_3	10 K $\frac{1}{4}$ w
R_4	500 Ω $\frac{1}{2}$ W
Triac	STO 24
Timer	555 IC

Ni-Cd Battery Charger
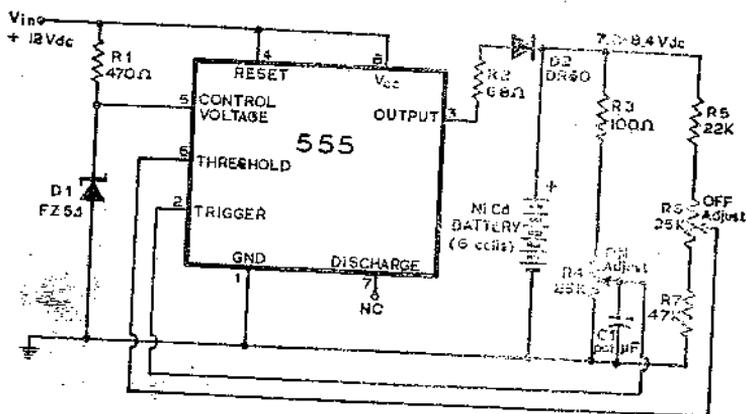
Fig. 25. Ni-Cd Battery Charger

The battery charger shown in fig. 25 maintains a full charge on a standby battery supply for an instrument that is always connected to the ac power line, whether in use or not. The two comparators of the IC 555 are used in this application to monitor the battery voltage and start or stop the charging process.

Zener diode D1 provides a reference voltage for both comparators through the timer's internal resistive dividing chain (fig. 2). The charge on and charge off points are adjusted by independent potmeters R4 and R6. Resistor R2 prevents the charging current exceeding 150 mA under all conditions. Diode D2 prevents discharging of the battery through the timer when its out put is in low state.

To calibrate the timer, substitute the Ni-Cd batteries by a variable voltage dc power supply and set the on and off potmeters to work at the desired voltages.

Parts List

|		
C_1	...	.001 μF ceramic
D_1	...	FZ 5.1
D_2	...	DR 50 or 1 N4001
R_1	...	470 Ω $\frac{1}{2}$ W
R_2	...	68 Ω $\frac{1}{2}$W
R_3	...	100 Ω $\frac{1}{4}$W
R_4, R_6	...	25 K linear Potmeters.
R_5	...	22 K Ω $\frac{1}{4}$W
R_7	...	47 K Ω $\frac{1}{4}$W
Timer	...	555 IC

Wide Range Pulse Generator
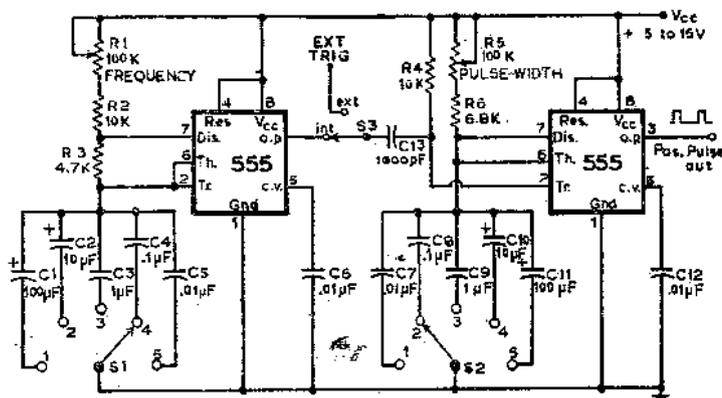
Fig. 26. Wide Range Pulse Generator

The general purpose pulse generator described here provides a wide range of frequencies in decade ranges and independent control of pulse width and frequency.

The first timer is used as an astable multivibrator (fig. 7) whose frequency can be varied over a 10:1 range by potentiometer, R1. Range selection is by switch S1. Mylar capacitors provide stability of calibration on high ranges. Tantalum capacitors, though costly are recommended for the same reason.

The output of first timer feeds the trigger input of the second timer, via S3, which can be used to select external inputs also if desired. The second timer is used as a monostable (fig. 6) whose output is a pulse having a width that can be varied over a range of 10:1 by R5. Switch S2 provides five ranges from 100 micro seconds to 10 seconds. The output is positive going pulses. In the external mode, any negative going pulse can be used to trigger the circuit. The following tables give the ranges of frequency and pulse width.

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Position of S 1	Frequency range	Position of S2		Pulse-width
1	0. 12 to 1.2 Hz	1	100µs —	1 ms
2	1.2 to 12 Hz	2	1 ms —	10 ms
3	12 to 120Hz	3	10 ms —	100 ms
4	120Hz to 1.2 KHz	4	100 ms —	1 S
5	1 . 2 KHz to 12 KHz	5	1 S —	10 S

Parts List

C_1, C_{11}	...	100 µF, 12 V electrolytic or tantalum.
C_2, C_{10}	...	10 µF, 12 V electrolytic or tantalum.
C_3, C_9	...	1 µF, mylar
C_4, C_8	...	0.1 µF mylar
$C_{,2}$ C_7	...	.01 µF mylar
C_6, C_{12}	...	.01 µF ceramic
C_{13}	...	.001 µF mylar
R_1, R_5	...	100 K potmeter
R_2	...	10 K Ω ¼W
R_3	...	4.7 K Ω ¼ W
R_4	...	10 K Ω ¼ W
R_6	...	6.8 K Ω ¼ W
S_1, S_2	...	Single pole 5-way switch
S_3	...	Single pole two way switch
Timer	...	555 IC, 2 nos.

Frequency Divider

The IC timer 555 can be used to divide a known frequency by adjusting the length of the timing cycle. This application makes use of the fact 555 cannot be retriggered during the timing cycle.
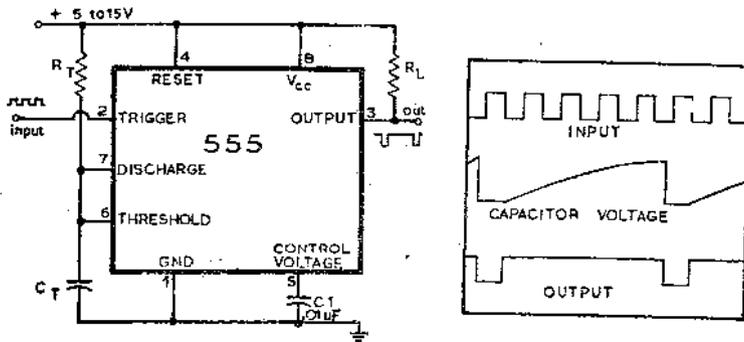

Fig. 27. Frequency Divider

Fig. 27 shows the external hook-up as well as the wave-forms for a divide-by-five circuit. The frequency to be divided is applied to trigger input (pin No. 2). The negative edge of the applied signal triggers the timer and capacitor C_T starts charging. During the charging process, further incoming pulses have no effect. The capacitor charges to its threshold value, when the circuit is triggered again, capacitor C_T discharges and circuit waits in this position to be triggered by next pulse. If R_T and C_T are chosen properly, the circuit can be made to trigger on second, third, fourth or fifth or more pulses and the output will be a frequency equal to the input frequency divided by that number.

Missing Pulse Detector
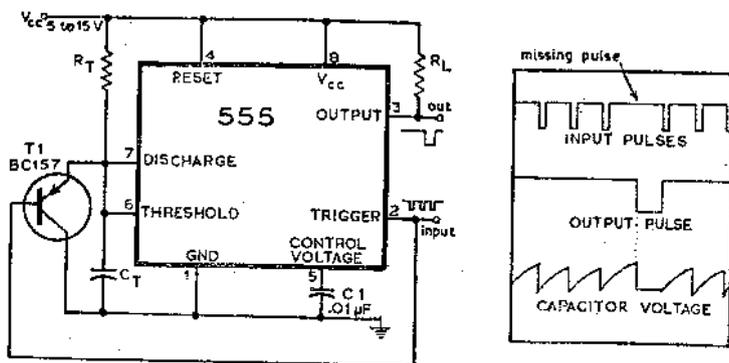
Fig. 28. Missing Pulse Detector

A 555 timer connected as shown in Fig. 28 can detect a missing pulse or an abnormally long period between two consecutive pulses in a train of pulses. Such circuits can be used to detect intermittent firing of a spark plug in an internal combustion engine or to monitor the heart beat of a sick patient.

The signal from the pick-up transducer is shaped to form a negative going pulse and appplied to pin 2 of the IC of which is connected as a monostable. As long as the spacing between the pulse is less than the timing interval, the timing cycle is continuously reset by the input pulses and the capacitor is discharged via TI. A decrease in pulse frequency or a missing pulse permits completion of time interval which causes a change in the output level. The different wave forms in this operation are also shown in the figure.

Light Operated Relay
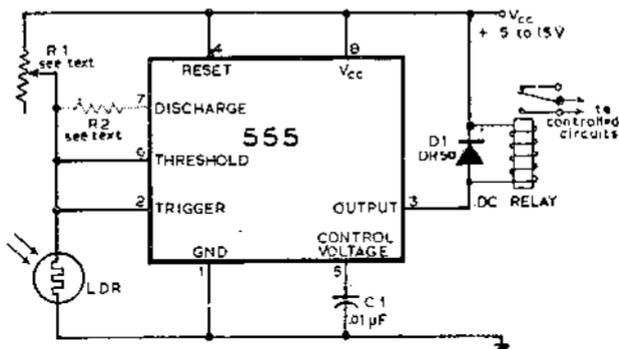
Fig. 29. Light Operated Relay

A light dependent resistor (LDR) can be used with a 555 timer to form a photo sensitive relay in an intruder alarm system or for switching on a light at sun set and off at sun rise.

Resistor R1 in Fig. 29 is so adjusted that under normal conditions when the light is falling on the photo-cell, the voltage across the photo-cell is less than $\frac{1}{3}$ Vcc. The actual value of R1 will depend on the resistance of the LDR. The output in this condition is high. As the day-light fades or the light on the LDR is interrupted by an intruder, the voltage across it rises above $\frac{2}{3}$ Vcc, tripping the IC flip-flop. The output goes low actuating the relay. When the light is restored, the voltage falls below $\frac{1}{3}$ Vcc, again tripping the flip-flop causing the output go high and the relay drops. The difference of $\frac{1}{3}$ Vcc between turning on and turning off voltages prevents relay chatter. This differential can be reduced by connecting a resistor R2 shown dotted in the figure. Its value is about one and a half times of the LDR resistance in its illuminated condition.

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Parts List

|		
C_1	...	.01 μF ceramic
D_1	...	DR 50 or 1N 4001
LDR	...	Light Dependent Resistor
R_1	...	Potentiometer (See Text)
R_2	...	See text
Relay	...	DC relay 6V or 12V operating current 200 mA max.
Timer	...	555 IC.

Temperature Controller
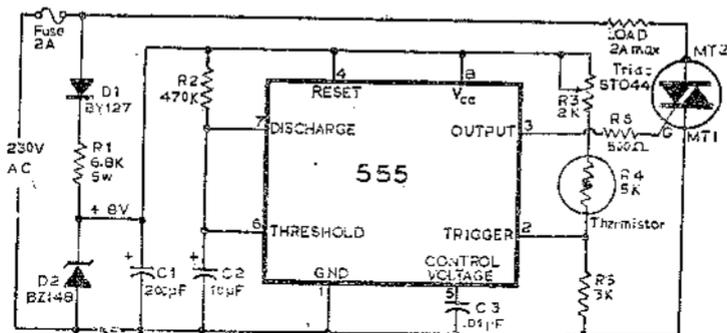
Fig 30. Temperature Controller

A 555 timer can be used with a thermistor resistor divider to build a temperature controller. The advantage offered is that a well regulated supply is not requird.

The dividing network (Fig. 30) consists of adjustable resistance R3, thermistor R4 and fixed resistor R5. When thermistor R4 cools below a set value the voltage at pin 2 of the 555 drops below $1/3$ Vcc. This turns on the triac controlled heater and also starts the timing cycle. If the thermistor temperature rises above the set point before the end of the timing cycle the heater shuts off at the end of the timing period. Otherwise the heater continues to stay on.

Thermistors of different values can be used as long as R3 + R4 = 2R5 holds true at the desired temperature.

Parts List

|		
C_1	...	200 μF, 12V electrolytic
C_2	...	10 μF, 12V electrolytic
C_3	...	.01 μF, ceramic
D_1	...	By 126 or By 127
D_2	...	BZ 148
R_1	...	8.2 k Ω, 10W
R_2	...	470 K Ω ¼W
R_3	...	2K Ω preset (see text)
R_4	...	Thermistor (see text)
R_5	...	3 k Ω, ¼W (see text)
R_6	...	500 Ω ½W
Triac	...	STO 44
Timer	...	555 IC.

Brightness Control Of LED Displays
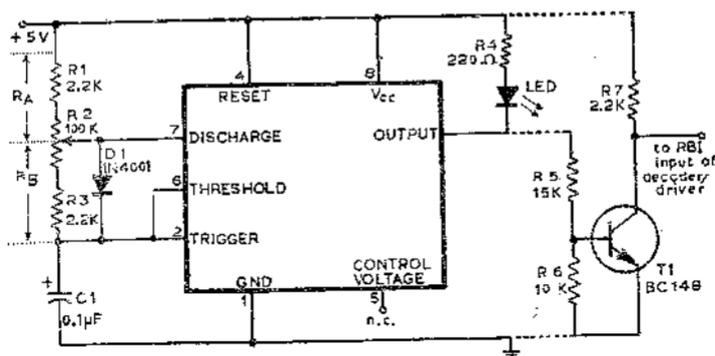
Fig. 31. Brightness Controller.

The visible brightness of a light emitting diode or seven segment LED type displays can be continuously varied by applying a pulsed signal and varying its duty cycle. The seven-segment decoders usually have a "blanking input" terminal to apply this type of control. If the frequency of the pulsed signal is above 50 Hz, the flicker will not be noticeable.

In Fig. 31 the charge and discharge times of the timing capacitor C_T vary with the setting of potmeter R2 but the total period remains the same. Thus the output signal frequency remains unaffected while its duty cycle is varied over a wide range. The output controls the brightness of LED's.

For applying to the ripple-blanking input of the decoder, a booster transistor may be connected as shown on the right side to provide sufficient drive voltage and power.

Parts List

|					
C_1	...	0.1 µF			
D_1	...	1 N 4001			
R_1 R_3	...	2.2 K Ω ¼W	R_6	...	10 K Ω ¼W
R_2	...	100 K Ω potmeter	R_7	...	2.2 K Ω ¼W
R_4	...	220 Ω ¼W	T_1	...	BC 148
R_5	...	15 K Ω ¼W	Times	...	555 IC

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Sequential Switching
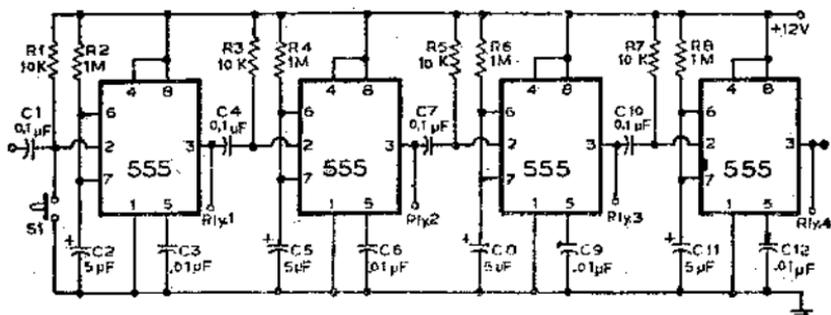
Fig. 32 Sequential Switching.

Several timers can be connected in cascade to control a number of operations in a sequential manner. Such circuits are useful in automatic control or automatic testing or sequential operation of machines. The on-time of each machine can be set independently.

When the power is switched on, all timers are in off state (output low). Pressing the start switch S1 momentarily triggers the first timer and its output goes high. After the time interval $(1.1 \times R1\ C1)$ its output again goes low, triggering the second timer and so on.

It is possible to connect the output of the last timer back to the first timer to trigger it. The action in this case once started by S1 will keep on repeating endlessly. The four timers shown in fig. 32 can be used to control four relays which will switch in a sequence 1,2,3,4, 1,2,.........Such sequential switching with equal time interval can be used to switch decorative lights or advertising displays. Two examples of connections which

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produce an illusion of a revolving wheel and that of a running border are shown in Fig 33 and 34.
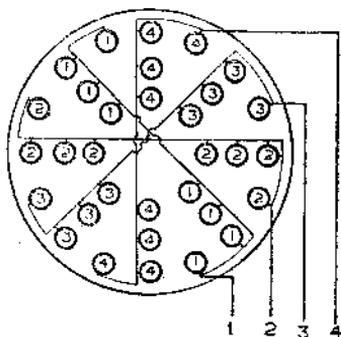

Fig. 33
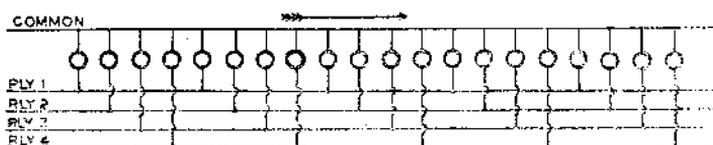
Fig. 34

Parts List

|		
C_1, C_4, C_7, C_{10}	...	0.1 μF disc ceramic
C_2, C_5, C_8, C_{11}	...	5 μF 12V Electrolytic
C_2, C_6, C_9, C_{12}	...	.01 μF disc ceramic
R_1, R_3, R_5, R_7	...	10kΩ ¼W
R_2, R_4, R_6, R_8	...	1M Ω ¼W
Rly 1,2,3 &4	...	12V D.C. relays, operating current less than 200 mA
Timers	...	555 (4 nos.)

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Long Duration Timer
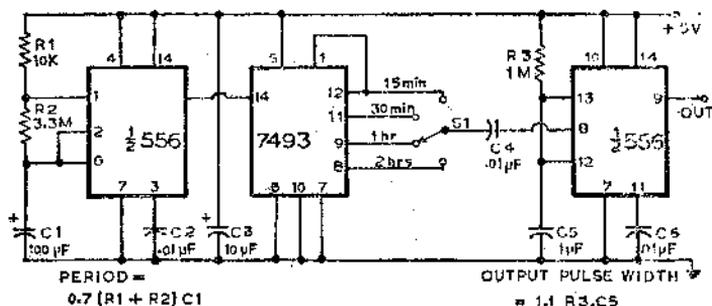
Fig. 35. Long Duration Timer

The 555 timer teamed up with a binary divider can provide delays as much as sixteen times that set by the time constant of the first timer. In fig. 35 a dual timer 556 is used but two single 555 timers can also be used instead. The first timer provides a delay of 7.5 min. and the divided outputs give a delay of 15 mn, 30mn, 1hr. and 2hrs. respectively. The second timer is used to obtain the desired output pulse length. Additional dividers may be added to give longer delays.

Parts List

C_1	...	100 μF, 6V electrolytic
C_2, C_4, C_6	...	.01 μF ceramic
C_3	...	10 μF 6V electrolytic
C_5	...	1 μF
R_1	...	10k Ω $\frac{1}{4}$W
R_2	...	3.3 M Ω $\frac{1}{4}$W
R_3	...	1 M Ω $\frac{1}{4}$W
SI	...	Single pole 4-way Switch.
Timer	...	556 dual timer or two nos. 555 timers.
Divider	...	7493 TTL IC.

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