

- [54] **ELECTRIC CHRONOMETER WITH BINARY READOUT**
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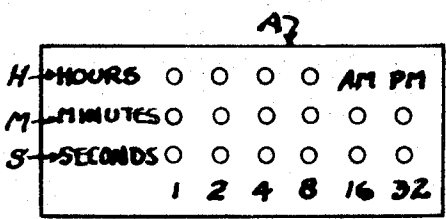
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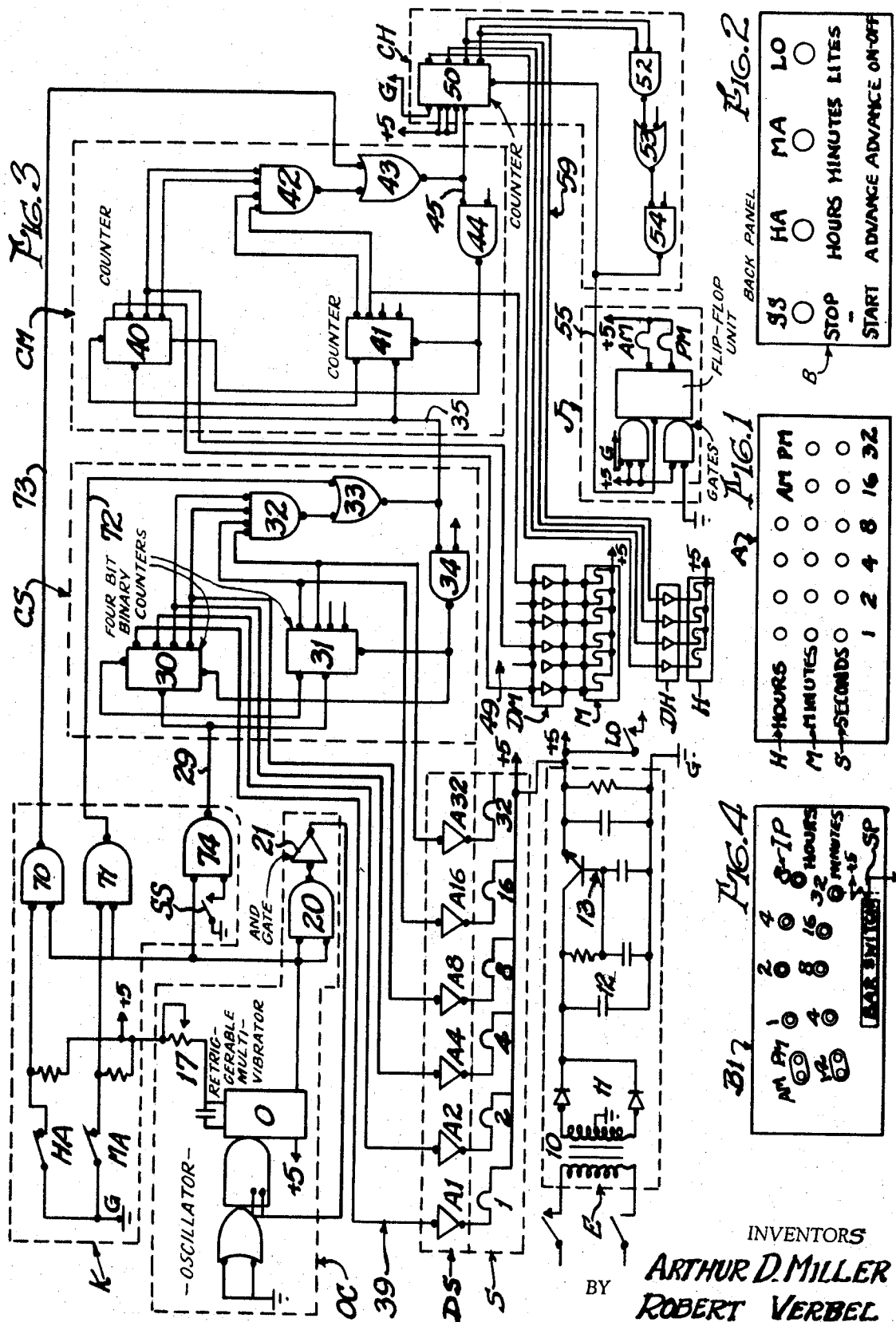
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[57] **ABSTRACT**
A chronometer provided with three rows of readout lights which indicate seconds, minutes and hours through binary counting of control pulses from an electronic pulse generating system. For setting the readout for correct time, a series of manual overcontrols are operable in conjunction with a start-stop control for rapid advance of minutes and hours counting. Provided, is a control for "dark" operation in which the counting mechanism continues to operate without energizing the readout lights.

7 Claims, 4 Drawing Figures





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ELECTRIC CHRONOMETER WITH BINARY READOUT

SUMMARY OF THE INVENTION

Using digital circuitry, the invention provides a series of pulse and light-energizing circuits for counting and indicating seconds, minutes and hours respectively, the minutes counts being triggered by the second counts and the hours counts in turn being triggered by the minutes counts. For hours indication, a bank of four lights having assigned values of 1, 2, 4 and 8 respectively, are operable for binary designation of hours up to 12, (e.g. by adding values 1 and 2 to designate hour 3, by adding values 2 and 4 to designate hour 6, and by adding values 4 and 8 to designate hour 12). For minutes and seconds indication, banks of 6 lights each having assigned values of 1, 2, 4, 8, 16 and 32 are operable for binary designation of seconds and minutes indications from 1 to 60 (e.g. by adding values 4, 8, 16 and 32 to indicate 60). For time-keeping operation, all counts are triggered by a succession of pulse intervals of one second duration, the end of the sixtieth second count triggering a minute count and the end of the sixtieth minute count triggering an hour count. AM and PM indications are triggered by the termination of each of two twelfth hour counts. For setting the time, manual overcontrols are operable for manual pulsing of minutes counts and hours counts respectively, directly in the respective minutes and hours circuits. To avoid interference with the manual setting operation by the time-keeping pulsing, a start-stop control is provided. For "dark" operation, the light-energizing outputs of the counting circuits can be inactivated by open-circuiting of such outputs while leaving the counting circuits fully operative.

The general object of the invention is to provide a chronometer having a novel read-out mechanism for indicating time of day. Specific objects are to provide a chronometer:

- a. that is operated by electric mechanism consisting of integrated electronic circuits and components such as transistors etc.
- b. that accordingly does not require the use of moving mechanical parts such as shafts, gears, escapement etc.;
- c. which can therefore be easily miniaturized for use in watches and small clocks;
- d. that can be inexpensively manufactured (e.g., by use of printed circuitry);
- e. that will give time readings in the form of various combinations of illuminated lights;
- f. that can be used as an educational tool for teaching a binary system of counting as applied to time of day;
- g. that will produce an unusual and stimulating visual display.

These and other objects will become apparent in the following specifications and appended drawings, in which:

FIG. 3 is a circuit diagram of the operative mechanism;

FIG. 1 is a view of the face of a chronometer embodying the invention; and

FIG. 2 is a view of the back panel of the same, with manual control buttons therein.

FIG. 4 shows a modified form of the invention

DESCRIPTION-GENERAL

Referring now to the drawing in detail, I have shown

therein, as an example of one form in which the invention may be embodied, a chronometer having an indicator face A embodied in a panel carrying respective banks of indicator lights H, M and S indicating elapsed hours, minutes and seconds respectively, so designated on the panel. In the seconds and minutes banks there are six lights each, having the assigned values 1, 2, 4, 8, 16 and 32, and these values may be shown by the corresponding numerals imprinted on the panel below the respective lights. In the back panel B (FIG. 2) are manual control buttons SS, HA, MA and LO, for starting and stopping the time-keeping operation, for manual advance of hours and minutes counting and indication, and for "dark" operation of the time-function without energizing the readout lights. Appropriate legends indicating such functions of the buttons may be printed on the back panel, as shown.

The operating mechanism, shown in block diagram in FIG. 3, comprises a 5 volt power supply E, a recirculating "one shot" oscillator OC; a series (six) of seconds indicator lights S; a similar series of minutes indicator lights M; a series (four) of hours indicator lights H; a series of six drivers DS for energizing the six indicator lights S; a similar series of six drivers DM for energizing the minutes indicator lights M; a series of four drivers DH for energizing the hours indicator lights H; a seconds counter circuit CS for controlling the seconds drivers DS; a minutes counter circuit CM for controlling the minutes drivers DM; an hours counter circuit CH for controlling the hours drivers DH; an AM/PM periods counter, driver and indicator light circuit J for operating the indication of AM and PM periods of the day; and a manual control circuit K for setting the time on the clock, cutting out the operation of the lights, etc.

DETAILED DESCRIPTION

All digital logic illustrated in FIG. 3 is comprised of transistor-transistor logic as is used in commercially available integrated circuits.

Power supply unit E is of conventional circuitry including a transformer 10 and a diode rectifier 11 for converting common household ac current into approximately 12 volt pulsating dc output; a voltage-divider unit 12 of capacitor and resistor elements delivering voltage at +5 volt and ground levels, (as indicated at +5 and G respectively) to the two sides of an output circuit; and a voltage regulator comprising a Zener diode, transistor capacitor and resistor group 13 across this output circuit, for maintaining 5.5 volts across the voltage divider 12 and for maintaining the transistor in a conducting condition and delivering 5 volts of pure direct current as the output at +5-G.

The oscillator OC is of a type generating a series of DC pulses of one second intervals which are used to advance the count of a binary counter. The oscillator O is a retriggerable monostable multivibrator, its pulse width determined by the external timing capacitor and resistor 17. The off time of the oscillator is lengthened by the delay of "and" gates 20 and 21. The output is then fed back to the input of the oscillator to retrigger the multivibrator.

The termination of the oscillator pulse is used to advance the second counter CS at one second intervals. Two four bit binary counters 30 and 31 are cascaded to produce an eight bit binary counter having the capability of counting from 0 to 255. By taking the outputs of the counter that are true for the counts of 4, 8, 16

and 32 to the inputs of an "and" gate 32 gives an output at the binary count of 60. At the count of 60 the output of "and" gate 34 causes the seconds counter to be reset to the count of zero and the output of gate 33 causes the minutes counter CM to advance by one count.

The seconds drivers DS utilizes a series of integrated circuit drivers A1, A2, A4, A 8, A 16 and A 32 which are capable of controlling the current from the indicators. As the outputs of the counters become true they initiate their respective drivers whose output then complete a current path to ground for the individual indicators as to illuminate the readout lights to display time by combinations of lights of which the following is illustrative:

1st second - light 1;
2nd second - light 2;
3rd second - light 1 & 2;
4th second - light 4;
5th second - light 1 8 4;
6th second - light 2 & 4;
7th second - light 1, 2 & 4;
8th second - light 8;
9th second - light 1 & 8;
10th second - light 2 & 4;
11th second - light 1, 2 & 8;

16th second - light 16;
17th second - light 1 & 16;
18 second - light 2 & 16;

28th second - light 4, 8 and 16;

40th second - light 8 & 32;

50th second - light 2, 16 & 32;

59th second - light 1, 2, 8, 16, & 32.

AM-PM register J is comprised of a J-K flip-flop that is set to change state each time a count pulse is on line 55. If one of the two states is defined as AM then the associated indicator will display AM, and the other state of the flip-flop and the associated indicator will display PM.

Lights control switch LO is a single pole single throw switch connected in series with the 5 volts supplied to the indicators. When the switch is closed the operation is normal. When the switch is in the open position the time keeping electronics works as normal but the indicators do not illuminate.

Minutes counter CM is triggered once each minute by the sixtieth pulse count of seconds counter CS, delivered as the output of that counter by the output line 35. Counter CM includes first and second counter units 40 and 41 and a decoder section comprising "and" gates 42 and 44, and an "or" gate 43, in an arrangement the same as that of seconds counter CS, the 60th count being delivered as an output of counter CM, through an output line 45, to the hours counter CH. The pulses counted by units 40, 41 are delivered to minutes drivers DM through six control lines 49 to control the bias on the driver elements so as to energize the minutes lights M in a succession the same as that of seconds lights S.

Hours counter CH utilizes a single counter unit 50, "and" gates 52 and 54, and an "or" gate 53, in an arrangement similar to that of counters CS and CM, co-

operatively controlling the hours drivers DH through four control lines 59, to control the application of the 5 volt power supply to the lights at +5. The twelfth hour counts of counter CH are delivered by an output line 55 to register J.

In the operation of the register J, the lights AM will each remain energized for a respective period of 12 hours, one light being extinguished as the other is illuminated. Simultaneously with each reversal of lights AM, PM, the hours counter CH will be reset and commence a new period of twelve hours counting.

Manual setting circuit K comprises the normally closed push button switches HA and MA, adapted to apply ground to "and" gates 70 and 71 which are connected in parallel to "and" gate 20 of oscillator unit OC to receive the control pulses of the oscillator. Gate 71 has a connection 72 to "or" gate 33 of seconds counter CS so as to deliver such pulses to minutes counter CM through the output line 35 of counter CS, thus effecting advance of the minutes time-keeping at the rate of 1 minute of advance in 1 second of actual time. Similarly, gate 70 has a connection 73 to "or" gate 43 of minutes counter CM so as to transmit the control pulses to hours counter CH by way of minutes counter output line 45, to effect hours advance at the rate of one hour per second of actual time. During such operations, it is desirable to prevent transmission of the control pulses through the normal time-keeping circuits. This is accomplished by actuating start-stop switch SS to ground on "and" gate 74 which disables the oscillator output line 29 so as to render its output ineffective to trigger the operation of seconds counter CS.

FIG. 4 illustrates a modification of the invention in a chronometer readable by a blind person. Instead of the visual indicator lights H, M, S, HA, MA, SS and LO, there is provided a corresponding series of tactile indicator plungers IP constituting the ends of the armatures of solenoids SP one of which is shown. Solenoids SP replace the lights S, M and H in a circuit which is otherwise the same as that shown in FIG. 3, including the drivers DS, DM and DH for energizing the solenoids of seconds, minutes and hours groups respectively. The indicator plungers IP are exposed in the chronometer face B1 and are operable by the solenoids SP so as to be projected for reading by the fingers of a blind person, with the same succession of tactile indications as the visual indications of FIGS. 1-3.

As a further modification, the invention may provide for counting and indicating hours on a 1 to 24 count basis, as in maritime time-keeping, and eliminating the AM, PM counting and indication.

We claim:

1. A chronometer comprising:

- a series of seconds indicators having assigned seconds values in a first binary counting sequence;
- a series of minutes indicators having assigned minutes values in a second binary counting sequence;
- a series of hours indicators having assigned hours values in a third binary counting sequence;
- a source of dc electric power for energizing said indicators;
- a pulse generator producing an output of pulses of one-second intervals;
- a seconds counter actuated by said generator output to count seconds from 1 to 60, said counter including means triggered by its 60th counts to deliver seconds output pulses at one-minute intervals;

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a minutes counter actuated by said seconds output pulses at one-minute intervals to count minutes from 1 to 60, said minutes counter including means triggered by its 60th count to deliver minutes output pulses at one-hour intervals;

means controlled by said seconds and minutes counting to energize said seconds and minutes indicators respectively in said binary counting sequences;

an hours counter triggered by said minutes output pulses to count hours of the day, said hours counter including means triggered by a terminal count thereof for resetting its counting to a starting count;

means controlled by said hours counting to energize said hours indicators;

said hours counts being restricted to a 1 to 12 count;

said resetting means being triggered by the twelfth hour count thereof;

a pair of AM, PM indicators;

and a flip-flop circuit triggered by each twelfth count of said hours counter for energizing said AM, PM indicators in alternating succession.

2. A chronometer as defined in claim 1:
said indicators being indicator lights for visible read-out.

3. A chronometer as defined in claim 1:

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said indicators comprising plungers for tactile sensing.

4. A chronometer as defined in claim 1:
and rapid advance means for setting time on said indicators, said rapid advance means comprising manual control means for triggering said minutes and hours counting manually at an accelerated rate.

5. A chronometer as defined in claim 1:
and means for arresting the transmission of the counting pulses to said indicators without arresting the counting operation.

6. A chronometer as defined in claim 1:
said seconds and minutes indicators each having a series of assigned values of 1, 2, 4, 8, 16 and 32 each and being energized in combinations providing binary readout in a numerical progression of indications of numbers 1 through 60.

7. A chronometer as defined in claim 1:
said hours indicators having assigned values of 1, 2, 4, and 8 and being energized in combinations providing binary readout in a numerical progression of indications of numbers representing hours of time keeping.

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