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ELECTRONIC CONTROLLED TIME PIECE

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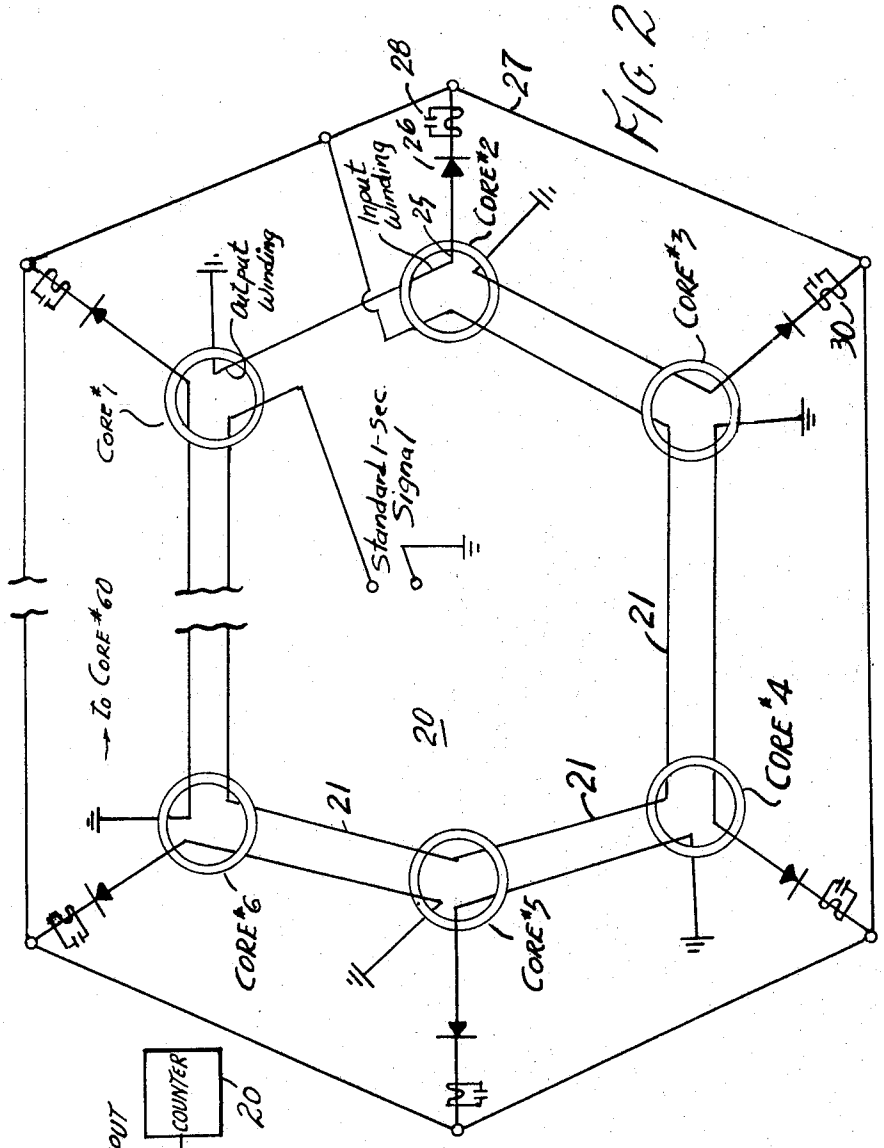


FIG. 2

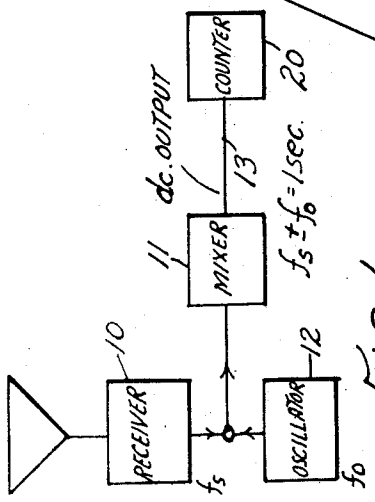


FIG. 1

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ELECTRONIC CONTROLLED TIME PIECE

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ABSTRACT OF THE DISCLOSURE

An electronically controlled time piece controlled by a standards signal from the Bureau of Standards time signal broadcasts consisting of a receiver for receiving the standards signals and developing therefrom a one second pulse of standards accuracy, a clock movement controlled by this pulse through a plural units ring shift register, seconds, minutes and hours, indicative of dual states of excitation and a visual time piece for displaying time movements responsive to said shift register as developed by the standards signals to display the actual time.

This invention relates to time-pieces in general and is particularly directed to electronically controlled time-pieces such as watches, clocks etc.

Time-pieces and/or watches presently are either mechanically or electrically driven and have their accuracy determined by the ability of their component parts to remain stable and constant in the face of certain changing variables such as pressure, temperature, moisture, etc. However, none of the time-pieces are either controlled or determined from and by electronic signals emanating from Government controlled stations whereby time standard signals are transmitted that contain precise second information. Such time standard signals are receivable anytime and anywhere in the world at the present time through one or more broadcasting channels depending on the locality.

To date, no time-pieces have been made which have the same accuracy as that generated by the Government time standard, which not only yield precise second information for the time but also adjusted according to the solar system for standard time. Further, no time-pieces have been made which can approach this standard especially in those areas where such time pieces undergo certain abnormal movements or are in environments detrimental to such time-pieces, such as caves, underwater, confined enclosures etc.

It is therefore the purpose and object of this invention to produce a time-piece having an accuracy comparable to that of the Government standard as broadcast on stations WWV and WWVH through the National Bureau of Standards in the United States and on other stations maintaining the same standard over the world.

Another object of the invention is to provide an electronic time-piece whose accuracy is determined and controlled by the Government standard time signals whether the time-piece be in enclosed or open surroundings.

A still further object of the invention is to provide a time-piece using solid state integrated timing circuits controllable by the Bureau of Standards timing signals to match its accuracy and having no moving mechanisms or parts, thereby reducing wear, tear and costs and increasing the life of the said time-piece, including its accuracy.

A further object of the invention is to provide a time-piece which uses micro-circuitry and requires little servicing and can be easily made dust-proof, humidity-proof, water-proof and temperature-proof and is rugged, durable and shock-proof.

Further objects and advantages will become apparent from a reading of the specifications and a study of the accompanying drawings, and wherein:

FIGURE 1 shows a simplified diagram according to one embodiment of the invention;

FIGURE 2 shows a ring shift register type of counter for controlling the accuracy of the time-piece.

Now proceeding with a description of the invention wherein, and wherever feasible, like parts or elements serving the same purpose and function will be designated by the same reference number. There is now shown in FIGURE 1 a time-piece according to an embodiment of the invention. In this one embodiment of the invention as shown in said figure, a receiver **10**, tuned to the standard broadcast signal, is received and fed to a second detector **11** along with signals from oscillator **12** heterodyned in the usual way so that a one-second pulse is produced which is the one-second standard modulation signal coming from the Bureau of Standards station. The one-second pulse signal **13** is then passed to a control motor or other actuating mechanism responsive to the one-second signal.

The one-second standard signal pulse, as derived from the mixer or second detector **11**, may be used to control other time-pieces such as that shown in FIGURE 2. Essentially, FIGURE 2 comprises an electronic counter **20** similar to a ring shift register as found in the computer art. The counter consists of sixty (60) magnetic cores (although six (6) are only shown for brevity), each representing a one-second time interval and connected by interconnecting input and output wires in a ring-like fashion.

The magnetic cores, numbered one through six, are all electro-magnetically linked by a common wire **21** to which the input signal **22** is applied and ground. Core number one has another wire **23** magnetically linked to it at one extremity **24** and terminating in ground, and the other extremity **25** magnetically linked with core two and terminating in a diode **26** and diode conductive ring or bus **27**. Between diode **26** and the conductive ring **27** there is magnetically coupled a small visual display indicator **28** which can be, for example, in the form of an electroluminescent cell that emits light upon excitation. Similarly, each of the cores are linked by wires **23**, each wire terminating in ground at one end, and at the other end terminating in a diode and ultimately to common conductive ring **27**.

In the form of a ring shift register, as an example, the standard second signal is used to drive a ring shift register of sixty units. The unit of the register, for example, has two states *a* and *b*. If the ring shift register has all units at state *b* except one unit at state *a*, the state of that unit is advanced to the next unit every time a driving pulse is applied. The application of the standard detected one-second pulse signal drives the shift register at a precise one-second time interval as determined by the standard transmitted. In other words, the driving pulse assures the shifting of the unit states at a precise time of once per second as dictated by the time standard.

Since only the shifting unit has a signal pulse connected therewith and not the other units, the signal pulse which belongs to that particular unit can be used for visual display control. Because the device is entirely electrical, no moving parts are necessary or used. The unit signal controlled display elements can thus be physically arranged in the form of a seconds scale. If light is to be emitted from each display element, one sees the display elements light up sequentially once per second dictated by the time

standard signal. When the display elements are physically arrayed in a clockwise manner, one sees a sequential or rotating light display that appears like a moving seconds hand at precise time intervals of one second.

Since the signal pulse of any particular unit of the above said ring shift register, called hereafter as the second ring shift register, exists once every sixty seconds, it can be used as a minute signal to drive another ring shift register of sixty units, called the minute ring shift register, which is basically the same and, in fact, can be constructed in the same manner as the second ring shift register. Similar to the seconds display, the minute signal of each unit can be used to control each of the minute display elements and can be arranged in a clock-wise minute division fashion. Since an electronic counter is used, the minute display is accurate to the time second standard signal.

Similarly, an hour signal obtained from any one unit of the minute ring shift register can be used to drive another ring shift register called the hour ring shift register, and to use its unit signal to control hour displays. The hour ring shift register may have twelve units for twelve hour displays, or may have twenty-four units for twenty-four hour display, such as twelve hour a.m. and twelve hour p.m., arranged clockwise on the time-piece for hourly display. These same principles may be used for time displays including day of the month, month of the year and etc., whenever desired.

In particular, with reference to FIGURE 2 showing the operation of the ring shift register, assume sixty magnetic ring-type cores are used and assume all cores are magnetized in a direction or state *b* except core #1 which is in state *a*. The first driving standard one-second pulse changes core #1 state from *a* to *b*. Voltage, by magnetic action, is induced across the output winding of core #1 and permits diode **26** to conduct, thereby increasing the voltage of common ring bus **27** to a higher positive potential thereby rendering all the remaining diodes linking the cores #2 . . . **60**, non-conductive with the exception of said diode **26**. The current through diode **26** is the input to core #2 and therefore excites the said core from state *b* to state *a*, and the display unit **28**, by virtue of the current flow, lights up the electro-luminescent cell **28**.

The above condition remains until the next standard second driving pulse comes, shifting state *a* to core #3 and lights up the display element **30** associated with this core. All of the remaining cores stay in state *b*. This procedure continues with the display of each unit sequentially lighting up according to the seconds timing pulses.

It may be appreciated that other type counters, other than the ring shift register may be used provided the standard seconds pulse signal is used for producing the display. Further, although magnetic cores are used for illustration purposes, other devices such as electron tubes, tunnel diodes, transistors and the like can also be used. Also, the display units can be other means other than electro-luminescent devices, such as storage elements where the light may be stored in the sense that a light flash can be made continuous until interruption, light reflective film or materials, refractive means, absorption means, and etc. Further, the art of setting initial core state, say core #1 at state *a* and the others at state *b* is well-known and have not been discussed here. Setting means, therefore, can be provided when desired for time setting.

On occasions when the time standard signals are not receivables, such as in insulated enclosures and the like, the time-piece may be provided with its own oscillator to generate one-second time signals (counters can be used so that the current art of having better constancy at higher frequencies can be taken advantage of to generate the desired second signal). Hence, in the absence of time standard signals, the time-piece will be as accurate as the time generating oscillators. However, such oscillators can be calibrated, adjusted and controlled by the time standard signals when available, as when the time-piece is removed from the said insulating enclosure. The art of such control and adjustment is available. For example, when calibration is desired, the oscillator and standard frequencies may be heterodyned to produce a zero beat. When this is done, the oscillator will be comparable to the standard and therefore accurate to the same degree.

The time-piece is an electrical instrument and can be stopped by merely disconnecting the power. The power itself may be furnished by modern dry-cell batteries, and because the power consumption is very minute, the battery will last a very long time. To set the time, all that has to be done is to provide the standard timing pulse, as previously stated, at the appropriate time. This can be done by the manufacturer, if necessary, and never touched again since the batteries will last indefinitely if they are of the rechargeable type.

It can be appreciated that other forms of the various elements and components may be applied without detracting from the true purpose and intent of the invention which is to produce a time-piece having an accuracy comparable to the standard as determined by the Bureau of Standards timing signals. For example, since at any particular place on the earth there is at least one channel of time standard signals available, the availability of such signal can be used by the invention herein. Further, the limited number of broadcast channels presently covering the world can be incorporated and utilized by the invention in such a way that the strongest signal from one of said broadcast channels available at any particular time and place would be automatically selected, detected and utilized. This scheme, while simple in principle and with little added complexity, enables the invented time-piece to have added protection against the possibility of failure of any one particular station. The art of automatically selecting the strongest signal is wellknown and need not be elaborated here.

Having defined the invention, what is claimed is:

1. An electronically controlled time-piece controllable in accordance with the Bureau of Standards time signal broadcasts comprising:

(a) signal receiver means for receiving said Bureau of Standards time signals,

(b) means for extracting from said receiver means a one second timing pulse whose accuracy is comparable to the said standards signal,

(c) a ring-shift register counter responsive to said one second signal for controlling the timing thereof to conform the said movement to the standard signal, said counter including intercommunication signal storage means, each having input, output, and excitation circuit means connected thereto, and

(d) time display means responsive to said controlled time movement means for displaying same in accordance with said standards signals.

2. An electronically controlled time-piece according to claim **1** and wherein said signal storage means includes magnetic cores having two degrees or states of magnetization.

3. An electronically controlled time-piece controllable in accordance with the Bureau of Standards time signal broadcasts comprising:

(a) signal receiver means for receiving said Bureau of Standards time signals,

(b) means for extracting from said receiver means a one-second timing pulse whose accuracy is comparable to the said standard transmission signal,

(c) time-movement means responsive to said one-second signal for controlling the timing thereof to conform the said movement to the standard signal, the said time-movement comprising a ring-shift-register type counter having a series of sixty on-off type memory units indicative of two states of excitation, such as state (a) and state (b), circuit means interlinking all of said units for receiving the said standard one-second signals, a plurality of circuit means interlinking respective pairs of units so that the extremity of one circuit comprises an input winding to one unit and the other extremity of

the circuit linked to the next adjacent unit comprises an output winding, one of said windings having a uni-directional current valve responsive to changes in energy state and terminating in a common bus, and,

(d) time display means responsive to said controlled time-movement means for displaying same in accordance with the said standard signals.

4. An electronically controlled time-piece according to claim 3 and wherein said time display means includes current responsive means disposed in said unit winding having the said uni-directional current valve and illuminated upon the receipt of said current to give a visual indication of the timing-movement.

5. An electrically controlled time-piece according to claim 3, and wherein said memory units are magnetic cores having dual magnetization states and said uni-directional valve is a diode.

6. An electronically controlled time-piece according to claim 4, and wherein said current responsive means includes electroluminescent cells.

References Cited

UNITED STATES PATENTS

2,662,366	12/1953	Koehler.	
2,968,797	1/1961	Sard et al.	235—92
2,970,294	1/1961	Guterman	235—92.13
3,063,233	11/1962	Bly.	
3,166,742	1/1965	Sherwin	58—50
3,217,258	11/1965	Arlin et al.	58—35
3,333,410	8/1967	Barbella	58—23

FOREIGN PATENTS

696,292	10/1964	Canada.

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