This invention relates to time-cost computers, and more particularly apparatus of the type in which a card is marked either by punching or by applying conductive matter or ink so as to indicate the beginning of a time interval. The marking on the card is then read electrically and used to actuate an indicating display arranged to show the price of the services corresponding to the time interval elapsed. More particularly, our invention is useful in computing and displaying the cost of parking fees or of the labor of a mechanic, or of any other service in which the price of the service depends on the number of time intervals consumed such as 1/2 hour, hours, or the like. Previous computers of the time-cost type have been proposed in many versions, but all have been too bulky and delicate, and consequently too expensive for wide-spread use, because they have attempted to compute the time interval elapsed with a degree of precision unnecessary for many common applications.

It is therefore the purpose of our invention to provide a simple and rugged device for computing and displaying the cost of services depending on the number of time intervals elapsed.

It is a further object of this invention to provide an apparatus which eliminates manual computation of the cost of certain services, and thus eliminates the error inherent therein.

We shall now explain the functioning of our device, reference being had to the accompanying drawings in which:

Figure 1 is an overall view of our device as it would appear when installed;

Figure 2 shows the detail construction of one embodiment of the timing device and marking and switching mechanism associated therewith;

Figure 3 is a detail of one embodiment of our sensing device; and

Figure 4 is a partial wiring diagram of our device.

In the embodiment herein, cam 14 is provided with ten pins 18 riding against a switch 20 in such a manner as to close switch 20 every six minutes, clock 10 and shaft 16 being so arranged that shaft 16 makes one revolution every hour. Cam 12 is provided with only a single pin 22 which engages a microswitch 24 and consequently closes microswitch 24 once every hour. Switch 20 controls solenoid 26 which by means of hook 28 advances ratchet wheel 30 one step each time it is energized. Ratchet wheel 30 has ten teeth, spring 32 returns hook 28 into position alongside the next tooth of ratchet wheel 30 when solenoid 26 is again deenergized. Ratchet wheel 30 is in turn fastened to shaft 34 on which is mounted gear 36 which engages a gear 38 mounted on a shaft 40 in a 1:1 ratio. A member 42, which may be either a spring detent or a rotary switch as will be more fully hereinafter described, is also mounted on shaft 34.

 Shaft 40 is provided at its lower end with an arm 44 provided at its outer end with a presser head 46. Located directly beneath the path of presser head 46 are ten plungers 48 urged upward by springs 50 and adapted for vertical movement in appropriate bores of a supporting member 52. The lower ends of plungers 48 are sharpened so that when a card 54 is interposed between support member 52 and base plate 56, the depressed plunger 48 will cut a hole in card 54. The material punched out of card 54 is ejected from the machine through bores 58 in base plate 56. In a similar manner, switch 24 operates a relay 60 which engages ratchet wheel 62. Ratchet wheel 62, which has twenty-four teeth, is mounted on shaft 64 and is connected to a spring detent or switch 66. Shaft 68 is driven from shaft 64 through 1:1 ratio gears 70 and 72. An arm 74 is mounted at the lesser end of shaft 68 and is provided with a presser head 76 which actuates one of twenty-four plungers 48 disposed within supporting member 52 in a second ring concentric with the ring of plungers actuated by arm 44.

It is to be understood, of course, that it is a matter of design which shaft the parts are mounted on, what the teeth numbers and gear ratios are, or how motion is transmitted from one shaft to another, and the above is cited as an example only.

A microswitch 78 is so arranged between the supporting member 52 and the base plate 56 that it will be closed when card 54 is fully inserted between the suppling member and the base plate. The closing of switch 78 operates solenoid 80 momentarily, until the closing of delay relay 82 reopens its circuit. As solenoid 80 is energized, arm 84 moves to depress both the shafts 40 and 68, whereby presser heads 30 and 62 engage the pins 48 above which they happen to be positioned at that moment and depress these pins 48 so as to punch two holes indicative of a given time into the card 54. After the momentary energization of solenoid 80, spring 86 returns arm 84 and shafts 40 and 68 to their rest positions. Delay relay 82 is so constructed as to close about 1/16 second after being energized and is provided so as to open the circuit of solenoid 80 after its initial operation and until switch 78 is reopened by the withdrawal of card 54, in order to avoid double punching. Relay 88 is provided to prevent the ratchet wheels from advancing during a punching operation.

If the card punching device is to be used separately from the read-out and indicating device, elements 42 and 66 may be so arranged as to have a detent function only, in order to center the presser heads accurately over each plunger 48. However, if the punching mechanism is to be incorporated in the same unit with the read-out and indicating device, elements 42 and 66 can be provided in the form of rotary switches which will then become respectively the switching devices 42 and 66 in Figure 4. The normal detent action of the rotary switches could then be used to provide a necessary detent function. If desired, ratchet wheels 30 and 62 may also be geared to appropriate counters 90 (Figure 1) so that the time of the punching operation may be continuously indicated in an indicator window 92 provided in the housing 94 of the device.

If the sensing unit is to be used alone and is not to be provided with a punching unit, it must of course be provided with its own timer 10, ratchet wheels 30 and 62, and switches 42 and 66, operated in the same manner as hereinafore described.

Figure 3 shows a sensing device which may be used in one embodiment of our invention. The sensing device 100 is composed of an insulating barrel 102 in which are mounted two concentric rings of contact fingers 104 and 106 corresponding to the two rings of plungers 48 in Figure 2. The barrel 102 is so supported that its contact fingers are normally spaced from the base plate 108. When a card 54 is inserted in guide 110 into the base plate 108, it closes switch 112 upon full insertion. This actuates solenoid 114 and delay relay 116, the latter being so constructed that it will close about three seconds after switch 112 has closed. Solenoid 114, when energized,
... by means of the lever 118. The card 54 keeps the contact fingers insulated from the base plate 102 except at the points where holes have previously been punched into the card. Stop 120, actuated by solenoid 122 through lever 124, prevents withdrawal of the card 54 until delay relay 116 closes, to prevent movement of the card until the reading operation has been completed. A relay 126 is provided to close concurrently with solenoids 114 and 122, for a reason to be hereinafter explained.

Referring now to Figure 4, there is shown therein a number of series connected resistors forming the resistor banks 202, 204, and 206. Banks 202 and 204 are each composed of nine equal resistors 208, each of which has a resistance value of one unit. Bank 206 is composed of twenty-three equal resistors 210, each of which has a resistance value equal to ten units. A single resistor 212 of a resistance value approximately equal to one hundred units is connected between resistor bank 206 and the negative side 218 of the D.C. supply 216. The positive side 218 of the D.C. supply 216 is connected to the top 220 of resistor bank 202. Switches 42 and 66 are so arranged as to short out a given number of resistors in banks 202 and 206, respectively, according to the time of day at the moment of actuation of the sensing device. Sensing rings 104 and 106 of sensing device 100 are arranged so as to short out a certain number of resistors in banks 204 and 206 according to the time punched on the card 54. A potentiometer 222 and a resistance 224 are connected in parallel with resistor banks 202, 204, and 206, and resistor 212. A wire 226 is connected from a point 228 between the bottom of resistor bank 206 and the top of the large resistor 212 through the contacts 230 of relay 126 to one side of the input to a vibrator 232 synchronized with the 110-volt A.C. power line (not shown). The other side of the input of the vibrator 232 is connected through wire 234 to the slider 236 of potentiometer 222.

The vibrator 232 "chops up" the D.C. input voltage applied to it and produces at its output 237, 238 an A.C. signal of a voltage proportional to the D.C. input voltage. This permits the use of an A.C. amplifier 240 for amplifying the signal appearing at 237, 238 and feeding it to the control winding 242 of a servomotor 244. It is to be understood, of course, that vibrator 232 and A.C. amplifier 240 could be replaced by a D.C. amplifier if desired, or that the entire circuit could be operated with A.C. The servomotor 244 drives shaft 246 which is adapted to turn the slider 236 of potentiometer 222. The shaft 246 is also provided with an arm which engages a cam 246—256 which are so designed as to successively actuate microswitches 258—266, each of which controls one of the indicators 268—276. It will be seen that the number of cams, switches, and indicators depends on the number of different charges which are expected to be made for the services under consideration. A stop 279 on shaft 246 engaging a fixed member 280 prevents further rotation of shaft 246 after the last switch 266 has been actuated.

In operation, the timer 10, through the intermediary of switches 42 and 66, at any given time short out certain resistors in the resistor banks 202 and 206. When a reading operation is to be performed, a card 54 is inserted in the sensing device 100, and as a result certain other resistors in banks 204 and 206 are shorted out during the reading operation. The resistors of the banks 202, 204, and 206 remaining in the circuit at that time have a total resistance proportional to the time used up in the performance of the services to be measured. In as much as the resistance 212 is constant, it will be seen that the potential appearing at wire 226 is an algebraic function of the number of resistors inserted in the circuit, and therefore of the time elapsed. The potential so obtained is fed into the vibrator 232 and creates a signal which is amplified by amplifier 240 and operates servomotor 244 until such time as the operation of servomotor 244 has turned the potentiometer 222 to the point where the potential on wire 234 is the same as the potential on wire 226 and a balance of the input to the vibrator 232 results, so that no more signal is transmitted to the amplifier 240. A device according to our invention in which the punching device and the sensing device are incorporated in the same unit, would then operate as follows: At the beginning of the time interval desired to be measured, a card 54 is inserted in the punching unit between base plate 56 and supporting member 52, Figure 2. As the card is advanced to the point where it trips switch 78, solenoid 90 is actuated and, through the intermediary of lever 84, shafts 40 and 68 and selected ones of the plungers 48, two holes are punched into the card 54. The position of these holes is then indicative of the time at the beginning of the time interval. Let it be assumed for purposes of illustration that the time at this moment is 12:34 p.m. The last movement of ratchet 62 has taken place at the last full hour which was 12:00. Consequently, arm 74 is now in the position where it will punch the plunger 48 in the outer circle corresponding to 12:00. As ratchet 30 is actuated once every 1/2 % hour its last actuation took place at 12:30 which was the end of the last previous 1/2 % hour interval. Arm 44 will therefore be in a position where its head 46 will actuate plunger 48 in the inner circle corresponding to 9/30 % hour. The marking on the card in this example will therefore consist of two holes indicating 12.5 hours.

Let it now be further supposed that the time interval to be measured ends at 3:15 p.m. At that time card 54 is inserted between base plate 108 and harbor 102 of sensing device 100. As card 54 is fully inserted into the sensing device it trips switch 112 and thereby causes the energization of solenoid 114 which by means of arm 118 brings barrel 102 containing sensing rings 104 and 106 down on card 54. At the same time solenoid 122 is energized and by means of lever arm 124 brings stop 120 down onto card 54 so as to prevent withdrawal of card 54 until the reading operation is completed. A delay relay 116 is provided for releasing solenoid 114 after approximately three seconds which is the approximate time required for a complete reading to be made. Thus much as card 54 has holes punched in it which correspond to 12.5 hours, the contact fingers of sensing rings 104 and 106 will remain insulated from base plate 108 except for the fingers corresponding to 12 hours and 9/30 % hour which through the holes in card 54 will come in contact with base plate 108. A circuit will thus necessarily be closed from the 12-hours contact finger of sensing ring 106, which is connected to point 282 on resistor bank 206, through the base plate 108 to point 284 between banks 204 and 206, and also from the 9/30 % hour contact finger of sensing ring 104, which is connected to point 285 on bank 204 through base plate 108 to the same point 284. At the same time, the passage of time has advanced switch 66 to the 15-hours (i.e. 3 p.m.) position where it connects point 286 to point 288 on resistor bank 206, and switching device 42 has come to the 9/30 % hour position where it connects 290 to point 292 on resistor bank 202. If the voltage of the D.C. supply 216 is 16 volts, the potential on wire 226 with respect to point 214 will now be

\[ E \times \text{resistance of resistor 212} \]
on wire 234 with respect to point 214 will then be E volts. A D.C. signal of

\[ E = \frac{E \times 100}{156} \text{ volts} \]

will therefore appear across the input to vibrator 232 as soon as relay 123 closes contacts 230. This signal is converted to A.C., amplified, and fed in a first phase to servomotor 244, which thereupon starts to turn in a first direction. When the motor 244 has rotated shaft 246 sufficiently to move the slider of potentiometer 222 to a point where the voltage picked off at point 236 is

\[ E = \frac{E \times 100}{156} \]

there will be no more signal at the input to vibrator 232, and consequently the servomotor will stop.

If servomotor 244 should overshoot the null point, the polarity of the D.C. voltage at the input of vibrator 232 would be reversed, and the A.C. signal delivered to amplifier 240 would be shifted in phase by 180°. This would cause the servomotor to turn in the opposite direction and thus return to the null point.

When a reading has been completed, delay relay 116 closes, whereupon relay 126 is de-energized and contacts 230 open. As this prevents any further signal from appearing at the input to vibrator 232, servomotor 244 will remain in the position in which it was when contacts 230 opened, until the next reading. If, now, cam 245-256 are so cut that when motor 244 drops in our example, switch 262 is closed and all other switches 258-266 are open, then indicator 272 will be energized. If indicator 272 is arranged, for example, to illuminate an indicator panel on which is marked the price to be charged for 2.7 hours of the service, such as, in our example, $0.90, then the actuation of indicator 272 will be indicative of the charge to be made.

The embodiment of our invention which has been described above is particularly adapted for use in a parking lot where cars do not remain overnight. As a result, the full hour at the time of read-out will always be equal to or later than the hour punched on the card 54, thus avoiding a negative reading, which would give a wrong indication. If it is desired to use our device for multi-day parking such as in hotel or airport garages, or for other uses, our device can readily be adapted therefor by the use of additional switches, sensing rings, and resistor banks.

It will be evident from the foregoing that the system of our invention can be carried out in many different embodiments, of which the foregoing description is only one example. For example, whereas the device described above uses the method of punching a card in order to produce an indication thereon, it would be equally possible to mark the card with a conductive material such as, for example, graphite or aluminum powder so that the contact fingers can establish an electrical circuit through such markings or the card may be blackened in appropriate places by the application of ink. In the latter case, photocells adapted to detect such markings on a card by photo-electric means could advantageously be used to replace the contact fingers in the reading operation, the photocells being so connected that the appearance of a mark within the field of “vision” of a photocell would result in the closing of any well-known electronic switching means or relay. It is therefore intended to cover herein all embodiments of this invention which fully perform the function of this device within the spirit of the appended claims.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. A time-cost computer comprising a bank of resistors connected in series across a fixed voltage source, a timer, a sensing device, means operated by said timer for short-circuiting selected ones of said resistors, said sensing device being arranged to short-circuit selected other ones of said resistors in response to coded information introduced into the computer, a variable voltage source, a null-seeking servomechanism arranged to vary the voltage of said variable voltage source, an amplifier for amplifying the voltage difference between said variable voltage and the voltage appearing across a predetermined portion of said resistor bank, a plurality of indicators, and means controlled by said servomechanism and calibrated in terms of cost per unit time for selectively energizing one of said indicators.

2. A time-cost computer according to claim 1, in which said sensing device is adapted to detect holes in a punched card.

3. Apparatus for computing and indicating data which is a predetermined function of the time elapsed between a start time and a finish time, said start time being recorded on a card in the form of indicia, and the said finish time, a circuit including a potentiometer, a voltage source connected across said circuit, a null-seeking servomechanism arranged to operate the slide of said potentiometer so as to balance the voltage across a predetermined portion of the chain of said circuit components, and indicating means calibrated so as to produce an indication representative of a predetermined function of the position of said slide.

4. Apparatus for computing and indicating data which is a predetermined function of the time elapsed between a start time and a finish time, said start time being recorded on a punched card in the form of perforations having positions on the card indicative of the time recorded, comprising: a plurality of sensing means arranged to be selectively closed by said perforations in accordance with the position of said perforations, a voltage source, a plurality of resistors connected in series across said voltage source, each of said sensing means being arranged to short-circuit a predetermined number of said resistors upon being closed, clock-operated switch means for independently short-circuiting a number of said resistors representative of said finish time, a circuit including a potentiometer, a voltage source connected across said circuit, a null-seeking servomechanism arranged to operate the slide of said potentiometer so as to balance the voltage at said slide against the voltage across a predetermined portion of the chain of resistors, and indicating means calibrated so as to produce an indication representative of a predetermined function of the position of said slide.

5. Apparatus according to claim 4, in which said indicating means comprise a shaft rotated by said servomechanism in accordance with the movement of said slide, a plurality of cams mounted on said shaft, and a plurality of indicators, each cam being associated with one indicator, and said cams being so disposed on said shaft as to successively energize said indicators as said shaft is rotated.

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