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DESIGN AND CONSTRUCTION OF A BILLING SYSTEM GAS METER

M.M. AHMED[1] AND M.H. KABIR[2]

[1]Department of Electrical & Electronic Engineering, World University of Bangladesh, Dhaka, Bangladesh; [2]Department of Applied Physics, Electronics and Communication Engineering, Islamic University, Kushtia-7003, Bangladesh.

Corresponding author & address: Md. Mostak Ahmed, E-mail: mostak321@yahoo.com
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ABSTRACT

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A billing system gas meter has been developed using locally available mechanical, electrical and electronic components such as metal cylinders, motor, nozzle bars, rubber belts, counter, operational amplifier, batteries and resistors etc. The designed meter can be used with single and double burners working in low pressure in the domestic places. Through this meter one can measure the total amount of gas consumed by a domestic user to calculate the bill (to be paid) by the gas utility company.

Key words: *gas meter, billing system, summing amplifier, motor*

INTRODUCTION

A gas meter is used to measure the volume of gas used as fuel such as natural gas (methane) and propane. Gas meters are used at residential, commercial and industrial buildings that consume gas supplied by a gas utility company. Gases are more difficult to measure than liquids, as measured volumes are highly affected by temperature and pressure. Gas meters measure a definite volume, regardless of the pressurized quanity or quality of the gas flowing through the meter. Temperature, pressure and heating value must be considered to measure actual amount and volume of gas moving through a meter.

The main aim of this design work are two fold: firstly it removes imbalance condition that a household customer uses a small amount of gas and another household customer uses a large amount of gas, but both of them pay the same bill. Secondly, most of the household customers are careless about the use of gas. They keep their oven ON for all the time. For this reason a large amount of gas is burned. But gas is one of the valuable assets of our country so it is required to save gas and utilize it in proper way.

In our country, the natural gas distributor gives line service in residential area. They take a fixed amount monthly bill (Taka 300.00 for one burner and Taka 450.00 for two burners). Even they do not measure how much gas is utilized by a consumer. Gas supply authority considers that a single burner user uses 1.84 m^3 gas per day for 5.25 hours duration and double burner uses 2.9 m^3 gas per day for 5 hours. Single burner burns 0.35 m^3 gas per hour. Double burner burns 0.58 m^3 gas per hour (Islam 2001). Authority selects monthly bill upon this consideration. Calculation based on this consideration is impractical. Every year there is a lot of system loss due to this impractical consideration. Subscriber uses a lot of gas beyond this consideration limit. To remove this imbalance condition and to reduce the wastage of gas, a billing system gas meter is essential. The billing system gas meter is required to measure the amount of gas used by a subscriber, which resembles with the electric meter. In the present work an attempt has been made to design and construct a low cost billing system gas meter for residential application.

MATERIALS AND METHODS

Block diagram of the designed billing system gas meter is shown in Figure 1. The designed meter has the following parts:

1. Buffer Section.
2. Electronic Circuit.
3. Display Section.
4. Power Supply.

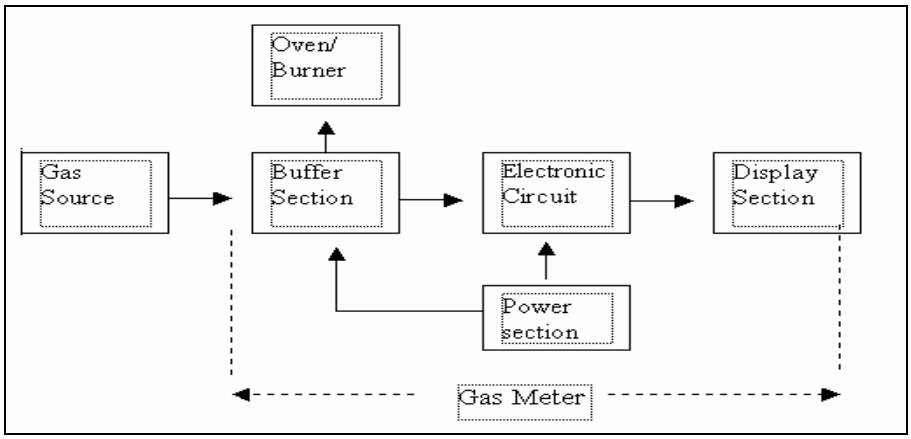

Fig. 1. Block diagram of a billing system gas meter

1. Buffer Section

This section contains two outlets that is used to supply gas to burner. Each of the outlets has 1mm diameter. This two outlets act like a valve that only opens at one side. This valve open depends on the pressure of gas flow. If user uses one burner then one outlet opens and when user uses two burners then two outlets open. The buffer section is packed into a cylinder. A Cylinder consists of metal pipe, which is attached to the nozzle. The radius of this cylinder is 2.5 inch. The nozzle is connected to another metal cylinder whose radius is 1.5 inch. Another 0.1 inch radius metal pipe is connected to 1.5 inch cylinder. This 0.1 inch pipe line provides input line of the gas. Similar pipe line is connected to the 2.5 inch cylinder which provides output line of the gas. The inner side of the cylinder has spring, connector, washer and cable. Two nozzles are attached together by welding. In the middle position of the two nozzle bar a stand is fixed. A spring protector and a connector is attached to the stand by bolts.

2. Electronic Circuit

Electric circuit contains a summing amplifier as shown in figure 2 which contains, resistors (Boylestad 2006), operational amplifier, PC board, connecting wires. The operational amplifier works as a summing amplifier. One of the most common applications for an operational amplifier is to add algebraically two (or more) signals or voltages to form the sum of those signals. Such a circuit is known as a summing amplifier, or acts as a summer (Gayakward 2002).

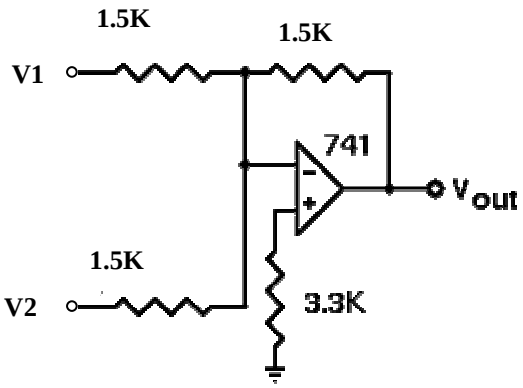

Fig. 2. Summing Amplifier

3. Power Supply

The power supply contains two 9V batteries which provide bias voltages for operational amplifier.

4. Display Section

The display section consists of motor, gear, rubber belt, counter etc.

EXPERIMENTAL DETAILS

When we have connected the gas meter then pressure of cylinder is 700 PSI and we measure this pressure by pressure measuring meter attached to the cylinder. Gas is passes into the meter to the burner and the counter rotates. Cylinder pressure per inch is 700 pound. We have used 1mm diameter outlet for gas flow. We have calculated the pressure of gas on 1 sq. mm outlet. We have also calculated the amount of gas flow at that pressure. Details calculation has described at calculation section. We have tried to find relation between gas flows and counter reading. At second step the gas meter was connected between to residential gas supply line and burner and counter reading and time was tabulated on table.

When one burner/oven is ON, the gas passes into the cylinder. The gas gives pressure on the nozzle bar. At that time the spring is compressed and the tiny hole is open. At this moment the gas passes into the tiny hole. One side of the nozzle bar is connected to a contact switch. A 1.5V supply is given in the nozzle bar. This is fed to the input of the OP-AMP. The OP-AMP works as a summing amplifier. The output of the OP-AMP is connected to the motor with the help of connector. The summing amplifier has two input. When one input is 1.5 V and another is zero volt then the output of the summing amplifier is 1.5 volt. This voltage is fed to the motor and the motor rotates at about 1200 rpm (Hubert 2003). Some of gear and belt are used to reduce the speed. For this reason the counter rotates at about 0.25 rpm.

When the oven is OFF, the spring is expanded and the tiny hole is closed. For this condition the switch is automatically removed from the connection. In this condition both of the input of the summing amplifier is zero volts. The output of the summing amplifier is zero. For this reason the motor can not rotate.

When two burners of the oven is ON, the gas passes into the cylinder. The gas gives pressure on the two nozzle bar. At that time the spring is compressed and the tiny holes is open. At this moment the gas passes into the tiny hole. One side of the nozzle bar is connected to a contact switch.

A 1.5V supply is given in both the nozzle bars. This is fed to the input of the OP-AMP. The OP-AMP works as a summing amplifier. The output of the OP-AMP is connected to the motor with the help of connector. The summing amplifier has two inputs. When both input is 1.5 V then the output of the summing amplifier is 3 volt. This voltage is fed to the motor and the motor rotates at about 2200 rpm. Some of gear and belt are used to reduce the speed. For this reason the counter is rotates at about 0.45 rpm.

When the oven is OFF, the springs are expanded and the tiny hole is closed. For this condition the switch is automatically removed from the connection. In this condition both of the input of the summing amplifier is zero volts. The output of the summing amplifier is zero. For this reason the motor can not rotate.

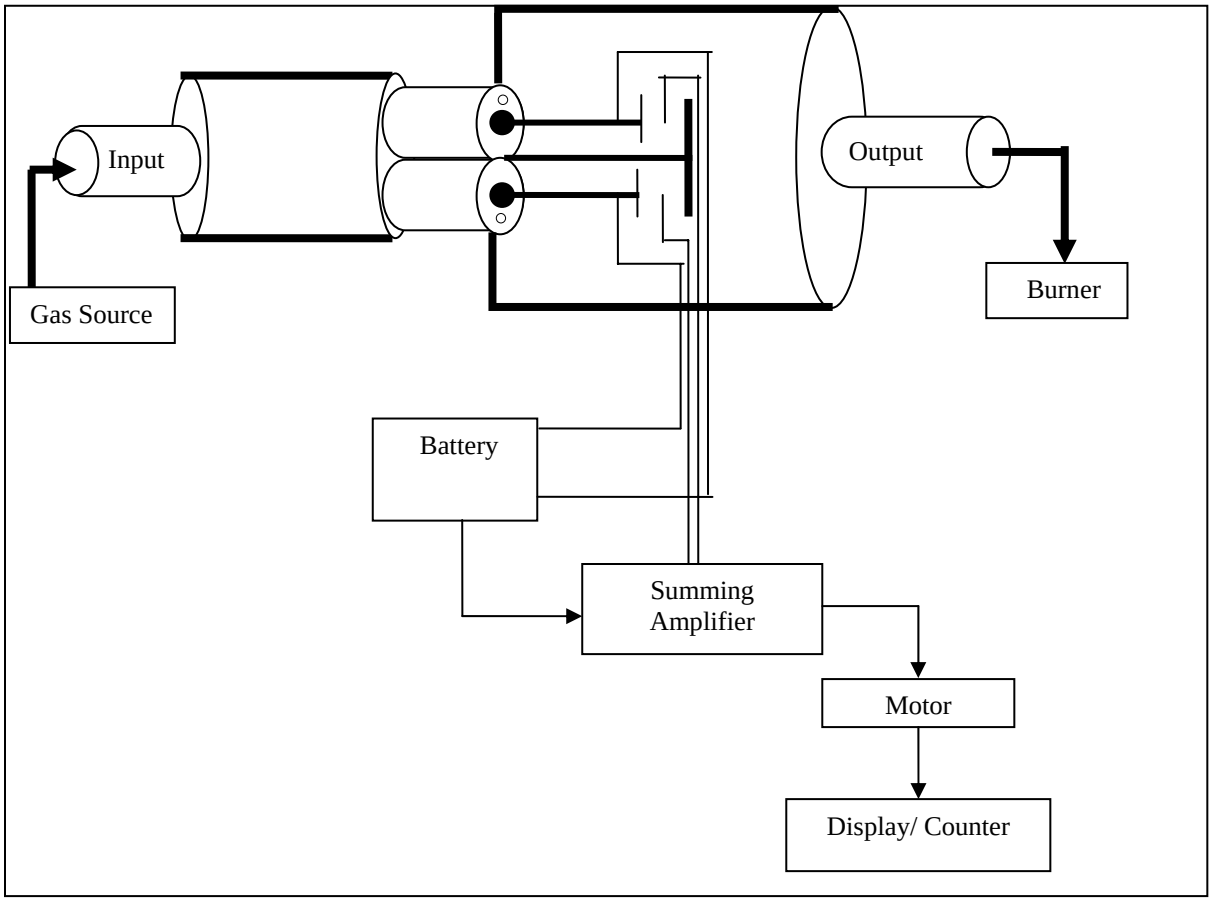

Fig. 3. A schematic diagram of a billing system gas meter

RESULTS AND DISCUSSION

Calculation for the amount of gas used in a single burner is shown in Table 1.

Table 1. When single burner is ON then above results obtained

Pressure (PSI)	Time (Hour)	Counter Display (Number in digit)	Gas Measurements (m^3)
700	1	15	0.275
672.5	2	30	0.55
645	3	45	0.82
617.5	4	60	1.1

When we have connected the gas meter to the gas cylinder then pressure of cylinder is 700 PSI and we measure this pressure by pressure measuring meter attached to the cylinder. Gas passes into the gas meter connected with burner and the counter rotates. We tabulate counter reading, time and amount of gas burn by the burner. We have used 1sq. mm diameter outlet for gas flow. We have calculated the amount of gas passes through 1 sq. mm outlet of the gas meter.

25.4 sq.mm area contains pressure 700 pound
1sq.mm area contains 700 / 25.4 pound = 27.55 pound
The cylinder pressure is 700 pound per/ sq.mm when they have 7 m^3 gas
The cylinder pressure is 27.5 pound per/ sq.mm when they have (7 X 27.5)/700 m^3 gas
= 0.275 m^3 gas

Calculation for the amount of gas used in a double burner is shown in Table 2.

Table 2. When double burner is ON then above results obtained

Pressure (PSI)	Time (Hour)	Counter Display (Number in digit)	Gas Measurements (m^3)
700	1	30	0.55
645	2	60	1.10
590	3	90	1.65
535	4	120	2.20

Primary pressure = 700 PSI (pound per square inch)
1 sq. inch = 2.54 sq. cm = 2.54x10 sq. mm = 25.4 sq. mm.
25.4 sq.mm area contains 700 pound
2 sq.mm area contains (700x2)/ 25.4 pound = 55 pound
The cylinder pressure is 700 pound per/ sq.mm when they have 7 m^3 gas
The cylinder pressure is 55 pound per/ sq.mm when they have (7X55)/700 m^3 gas
= 0.55 m^3 gas

From both the table we see that when 1.1 m^3 gas passes into the meter then the counter shows the number 60. i.e. 1 m^3 gas passes into the meter then the counter shows the number 55.

Total amount of gas (Burnt by the burner) = (Display number/55) m^3
Total cost (Taka) = (Total amount of gas X Rate of gas)
= (Display number/55) X Rate of gas

CONCLUSION

Approximate cost of the designed billing system gas meter is Tk. 1200. This meter can be used in home in which low pressure and small amount of gas are needed. If one want to use this meter in factory then the diameter of the outlet must be increased. The rate of the gas which is used in factory must be changed. The meter can be used exclusively for billing of the house hold application. It can be made locally on commercial basis. This meter can also be developed as a digital meter by using micro controller and LCD display as a prepaid gas meter.

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