The Design Process of Commercial Circuits

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***Abstract* – Electrical circuits are the cornerstone of the electrical based world. Circuits are used in every corner of our daily life such as in ignitions that start our cars, to the lights that turn on at the end of the day. Designing of the circuit is a meticulous and complex process in which we have to keep in mind all of the components included in the circuit and how they interact with each other. Most of the time these circuits have overlapping components that function separately, meaning, a small error can lead to a failure in the whole circuit due to the current being unable to flow through the system. We also need to take into account the cost, resource and size for maximum efficiency for the use of the circuit in a commercial setting. Understanding the use and limitation of the individual components will lead to a better and far more effective circuit.**

Keywords - ***battery life, commercial, component, current, electrical circuit, flow, wire***

I. INTRODUCTION

The investigation of electricity, more precisely static electricity, started hundreds of years ago, yet the invention of the battery marks the start of a major growth in the discovery of electricity. The battery was invented in 1800 by Alessandro Volta and the term used to describe the pressure that pushes electricity, voltage, was named after him. The battery was necessary because without a continuous current, there is no use for the application of energy [1]. The first widespread commercial application of electric circuits was used by Thomas Edison who invented the lightbulb. Now in modern days, electrical circuits are in every part of our life. It is used in commercial devices such as cellphones and other electrical devices. An electrical circuit requires the 3 components of voltage source, a load and a conductive pathway [2].

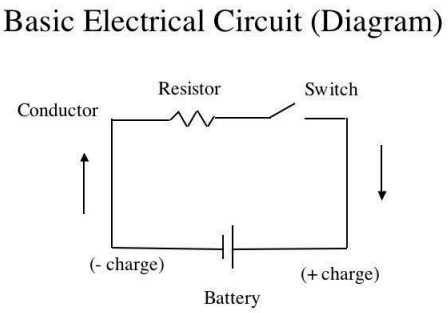

Fig. 1: A diagram of a basic circuit that shows common components used. Source [6]

The voltage source (battery) , as the name suggests, supplies the voltage for the circuit and without it the circuit will not be able to continuously work. The conductive pathway (wires) carries the voltage supplied by the voltage source. Finally the load (the electrical device) which holds a resistor in them, uses

the electricity carried by the conductive pathway to conduct the electricity like light or heat.

II. COMPONENTS IN A CIRCUIT

There are many components in a circuitry that results in a functional system that can be used for commercial usages. Some of these components are resistors, transistors, switches, and breadboards.

A. Resistors

Resistors are components in a circuit that limit the flow of the current in an electrical circuit. Most of the time, resistors are necessary because the current from the battery may be too strong for the load and it may burn out the component. Resistors are color coded to label the ohms of each resistor. Resistors work differently for a series circuit and a parallel circuit. In a series circuit the total resistance of the circuit can simply be added but for a parallel circuit, the total resistance must be added inversely.

B. Transistors

Transistors are a component in the circuit that controls the flow of electricity by using the three sections of its body. The three parts are, the emitter, the base and the collector. The two sections, n-type and p-type, as seen in Fig. 1, are used to move the circulation around and allow a larger amount of electricity to flow from the collector to the emitter.

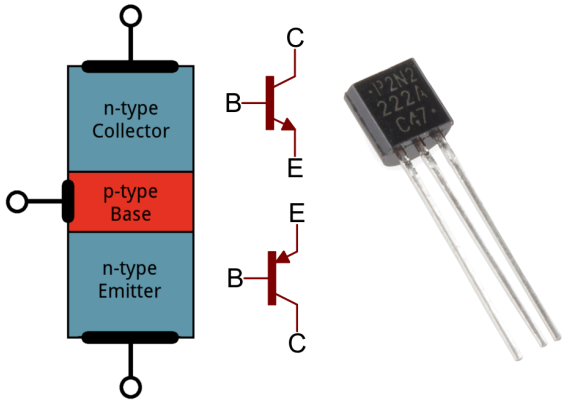

Fig. 2: A drawing of a transistor and an image of how it looks in real life. Source [3]

C. Switches

There are multiple types of switches that can be used for a circuitry–slide switch, toggle switch and dip switch. The switch controls whether the circuit is open or closed. If the switch is ON the circuit is closed meaning the current can flow through but when the switch is off the current will be open meaning the current cannot flow throughout the circuit.

D. Breadboard

The breadboard is a plastic board with multiple holes which can attach components for the circuit. The breadboard is often used for prototypes because the connections are not permanent. This means, if there is a mistake or if we want to change something in the circuit it is much easier for us to switch and move around the components on the breadboard. The bread boards are often used for beginners because of this property. It is also reusable just by simply removing the components.

III. COMMERCIAL USAGE OF CIRCUITS

From a commercial point of view, circuits are vital organs that support daily electronic systems. Circuits connected with a web of wiring supply electricity to outlets, lighting, etc. The incorporation of electrical wiring in a building requires many steps to ensure safety and success. The first step is to create a detailed electrical plan that outlines essential information for the electrical engineers. Critical details like the location and capacity of the circuits depend on the number of outlets and other electrical fixtures that the circuit will have to supply electricity to. Wires then connect to the electrical panel, housing the neatly labeled circuits. Circuit breakers and fuses are also present for safety.

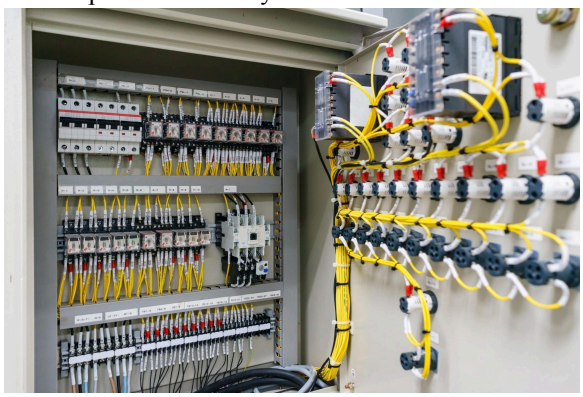

Fig. 3: Commercial electrical panel with switches and circuits neatly organized. Source [5]

The entire electrical system is then checked and inspected with tools like a multimeter to test the voltage, the current, and other factors. Inspections like this occur periodically to make sure everything is running smoothly. During inspection, electricians can spot any outdated equipment that needs upgrades, problems in the wiring that poses a threat,

malfunctioning wiring, and more.

IV. DESIGNING A CORONAVIRUS DETECTOR

Our team took on the challenge of designing a coronavirus detector circuit using logic gates. There would be 4 types of lights: green, yellow, red, and the alarm. When these lights would turn on depends on three risk factors. Coughing, vomiting, and fever are common symptoms of an individual affected with the coronavirus. The green light would turn on if none of the risk factors are detected, the yellow would turn on if one risk factor is detected, the red light would turn on if two risk factors are detected, and finally the alarm would sound if all 3 risk factors are detected. Creating a circuit that follows this was an imposing task but we broke it down into digestible bits. First we started by creating a truth table on paper of all the possible outcomes.

V. BUILDING OF THE CIRCUIT

Since there are four different outcomes – green light, yellow light, red light and alarm, the task was divided into 4 parts correspondingly.

To get a visual and clearer understanding of each line of circuit, a truth table was first created. A truth table consists of 2 or more variables and the values they pick. The outcome for each combination will be listed at the right-most column. In this specific situation of the coronavirus circuit, the values of independent variables – cough, barf, and fever can be represented by 0s and 1s. When the variable is 0, it means that the factor does not exist, and when the variable is 1, the factors do exist. Similarly, the outcome also has two values, when they are 0, light turns off, and 1, light turns on.

Secondly, we learned the functions of AND, OR, NOR, XOR, NAND, NOT gates. Through various combinations of the input values of the gates, the expected outcome will be generated. For instance, if green light is turned on, the input value of the flip flop should be 1. Therefore, the final outcome of comparison for the three factors should be 1. In addition, since we were using the 2-inputs gates, two factors should be chosen and compared first. Then, their outcome could be used as an input and compared with the third factor. Here, OR gates are used because three 0 is required and since OR gates result in 0 only when the two input values are 0. Therefore, using two OR gates that have the outcome of 0, we can make sure that the three input values are all 0. However, to make sure the green light bulb will be on, the final outcome 0 should be 1, so the second OR gate should be changed to NOR gate, which gives exactly the opposite value of OR gate.

After all lines of circuit for all possible situations of lighting three colors of light are designed, we combine them into one single diagram on paper. In this diagram, some outcomes of some gates are also the input values of other gates as shown (Fig. 4). Lastly, we copy the diagram on paper to the circuit lab and make it look more tidy and aesthetically pleasing as shown (Fig. 4).

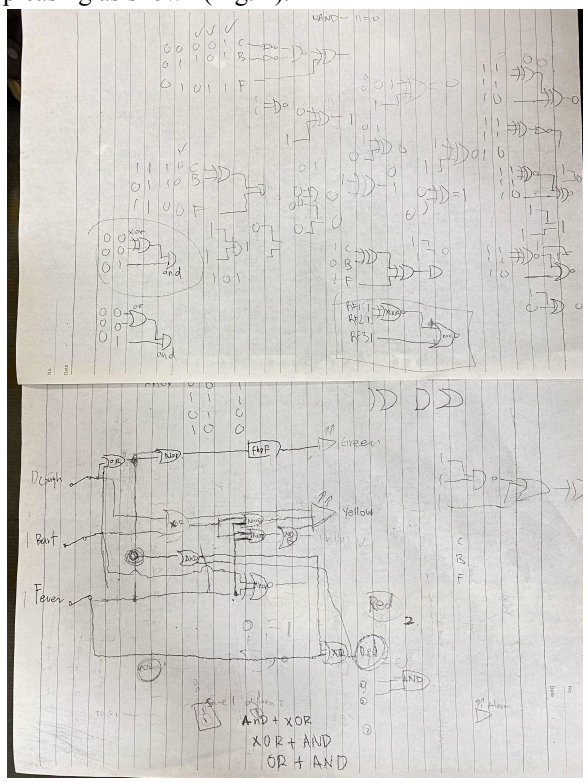

Fig. 4: Diagram drawn by Mida Li for the Logic circuit.

VI. CONCLUSION

The formulation of commercial electrical circuits necessitates the integration and application of fundamental circuit principles, electrical components, and various logic gates. The practical implementation of these electrical circuits has significantly enhanced the quality of life, such as electrical railways nowadays and serving as crucial resources for industrial applications. The circuit for detecting coronavirus could be an good example as it helps people detect health conditions and get help in time.We design this circuit with 3 factors and connect them through different logic gates (and, or, nor gates

and etc), and testing them as if the lightbulb represent for each factor can be correctly light up. Upon successful design and construction, the circuit can be introduced to the commercial market, contributing to the improvement of societal life security.

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