POST-GRADUATE PROFESSIONAL EXPERIENCE IN ELECTRONIC AND ELECTRICAL ENGINEERING

A REPORT SUBMITTED TO
THE NIGERIAN SOCIETY OF ENGINEERS

BY

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CERTIFICATION

I certify that the works against which I have signed were carried out by the candidate and supervised by me.

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ABSTRACT

A brief but illustrative account of the author's acquired experience in the areas of consultancy, teaching and research, and repair and maintenance is presented.

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INTRODUCTION

My journey into the engineering profession started in December 1984 when I was offered an admission into a first degree programme in Electronic and Electrical Engineering at the Obafemi Awolowo University,Ile-Ife (then called University of Ife).

Since graduating in September,1989,I have worked in various places.My first appointment was with the Directorate For Food, Road and Rural Infrastructures (DFFRI). This was during my National Youth Service Programme from 2nd of October 1989 to 2nd of October,1990,I was then the monitoring officer for DFFRI attached to Owo Local Government of Ondo State. My duties were primarily supervisory in nature and mostly unrelated to the field of Electrical Engineering. Because of my strong interest in Electrical Engineering,I undertook various repair and maintenance services for the local government.I singlehandedly made a design of the street lighting scheme for the local government secretariat.

On completion of my National Youth Service Programme in October,1990,I joined the employment of SMATEK Electronic Services as a Service Engineer.

In July 1991, I joined the Department of Electronic and Electrical Engineering, Ladoke Akintola University of Technology, Ogbomoso as a Graduate Assistant. The University is a young one having been established in October, 1990. I am one of the pioneering members of staff in the Department of Electronic and Electrical Engineering. Under normal conditions, the post of a Graduate Assistant is supposed to be a training one. Because of the age and the staff strength of the department which are relatively small, I have always been saddled with series of responsibilities which should have otherwise been handled by a more senior officer. This situation exposes me to a wide range of experience in teaching, consultancy services, research, laboratory and general administration.

This report is a brief account of the professional experience acquired at the three places where I have worked so far. I have tried as much as possible to limit the report to only the experience acquired in the field of Electronic/Electrical Engineering.

The main body of the report has been arranged into three chapters. Chapter II is on Consultancy Services. Under this chapter, various electronic/electrical engineering designs and construction, are discussed to some details. Chapter III is on Teaching and Research where I discuss my past and present efforts in Teaching and Research activities. Chapter IV discusses the experience acquired in Repair and Maintenance.

CONSULTANCY SERVICES

2.1 Design and Construction of Traffic Diversion Indicator

It is often necessary to create a diversion route for traffic whenever a road is rendered impassable.This might be as a result of the road being in a state of disrepair, accidents, or big tree falling across the road. Most of the time, diversion route is created when a road is undergoing construction or rehabilitation.

When a diversion route is to be created, there must be a sign to direct the traffic. The sign is usually placed at a point before the diversion route. The usual way of doing this is by placing a wooden post on which a big arrow has been drawn by the side of the road, the arrow pointing in the direction of the diversion route. This indicator is sometimes not easily visible from a long distance and it is not impossible for vehicles to pass without indicating it.

It has been discovered that a more effective signalling can be done by replacing the usual wooden post with a system of pulsing incandescent lamps arranged in form of an arrow showing the direction of the diversion route. One of the advantages of this system is that an oncoming vehicle can see the diversion sign when it is several metres before it.

In 1992, a group engaged the services of my department in designing a system that could perform the function of a diversion indicator, and constructing a model circuit.

This job was assigned to me and after some effort, I came up with the circuit shown in Fig. 2.1.

2.1.1 Operation

When a diversion in the left hand direction is intended, pushbotton L is pressed and released once. This action sends a clock pulse to the flip-flop FF1 which has been configured to toggle on receiving a clock pulse. Assuming the Q output of FF1 is initially at logic 0 it becomes high (i.e. logic 1) on receiving the clock pulse. Since the input (1) of the OR-gate 1 of IC3 is now high the output (3) is also at high logic level.

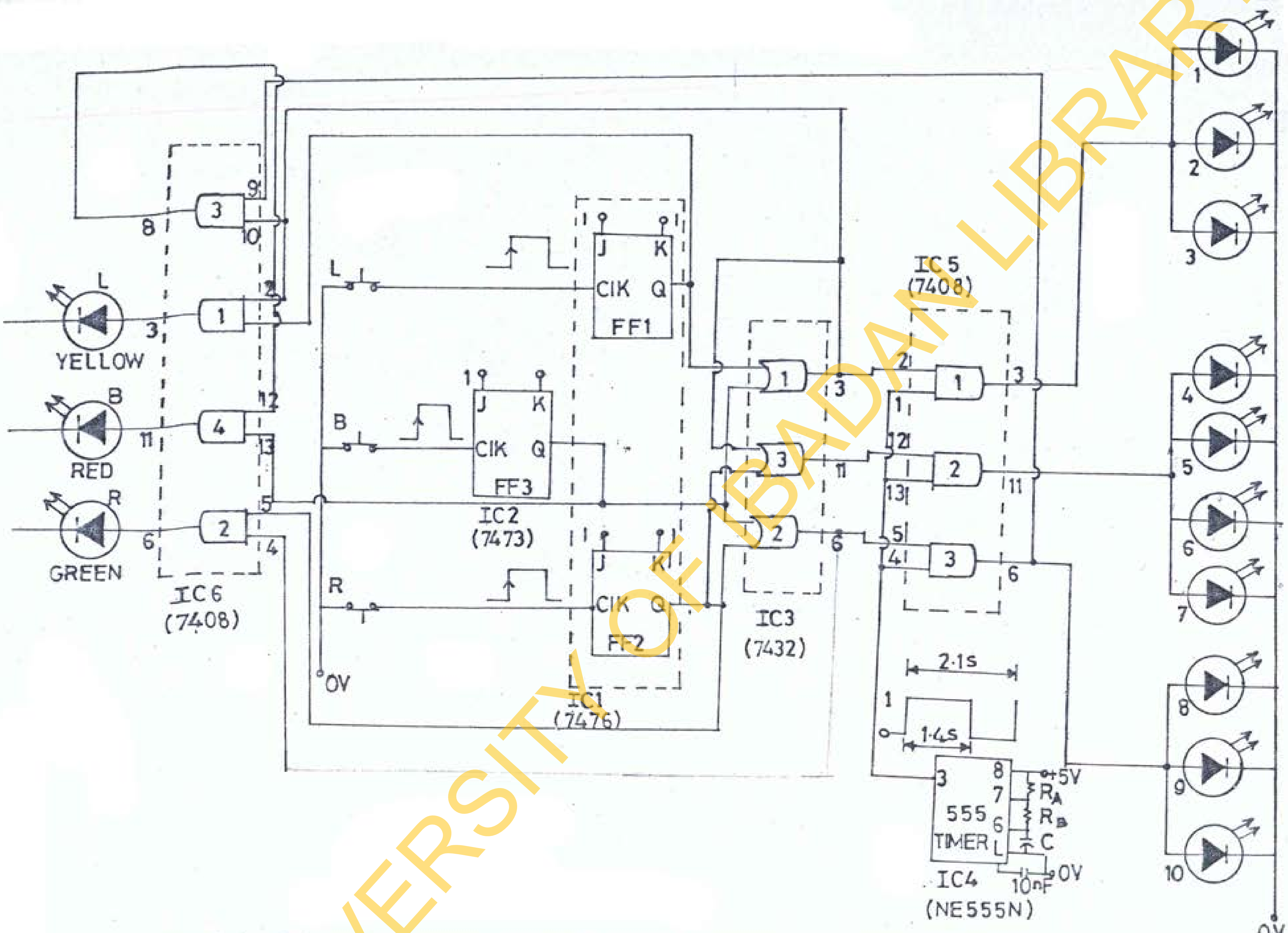


Fig.2·1 Schematic diagram of a Traffic Diversion Indicator System.

The output (3) feeds the input (10) of OR-gate 3 such that the output (11) is also **high**.

The 555 timer (IC4) is configured to operate in an Astable multivibrator mode. The expressions for the ON and OFF time of the multivibrator are given by

$$t_{ON} = 0.695\ (R_A + R_B)\ C \qquad 2.1$$

$$t_{OFF} = 0.695\ R_B C \qquad 2.2$$

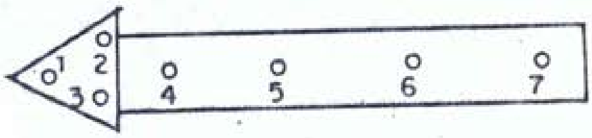
With the values of $R_A = R_B = 10\ K\Omega$ and $C = 100\ \mu F$, the (ON) time is obtained to be 1.4 sec. and the OFF time 0.7 sec. The multivibrator thus has a pulse period of 2.1 sec. or a frequency of 0.05 Hertz.

The output of the timer is connected to the input of AND-gate 1, input (9) of the AND-gate 2 and input (4) of AND-gate 3, all in IC5.

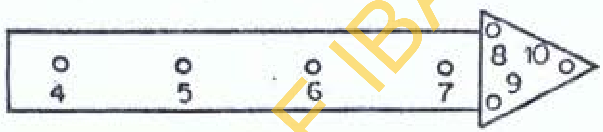
Since input (2) of AND-gate 1 and input (10) of AND-gate 2 are now high, the outputs (8) and (11) of AND-gate 1 and 2 respectively **follow** the output of the 555 timer. So a pulsating current is sent to LEDs 1,2,3,4,5,6, and 7. Since these LEDs are arranged to form an arrow pointing in the left hand direction, the indication is that the diversion is towards the left hand direction as shown in Fig. 2.2 (a).

A feedback path is provided from output (3) of OR-gate 1 of IC3 and output (14) of FF1 through AND-gate 1 of IC6 to LED Yellow. This tells the operator that the indication is towards the left.

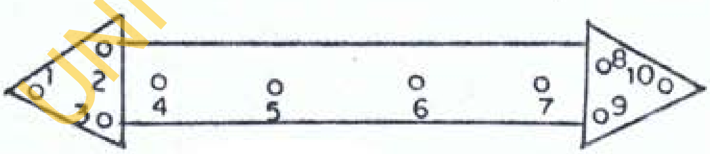
Similarly, if the diversion is intended to be the right hand direction, pushbotton R is pressed and released once. This sends a clock pulse to FF2 bringing its output initially at low logic level to high logic level. This in turn brings the output (6) of OR-gate 2 and output (11) of OR-gate 3 both in IC3 to logic 1. Consequently, LEDs 4,5,6,7,8,9 and 10 receive pulsing currents from the outputs of AND-gates 2 and 3. The pulses are such that the LEDs are alternatively **ON** for 1.4 sec. and OFF for 0.7 secs. The arrangement of the LEDS as shown in Fig. 2.2(b) indicates the diversion is towards the right.



(a) Diversion to the left



(b) Diversion to the right



(c) Diversion to both the left and the right

Fig.2.2 The displays of the traffic diversion system for different directions of diversion

In a situation when the traffic can go either way, pushbotton B is pressed and released once. The end effect of this action is that all the LEDs receive pulsing current and the display is as shown in Fig. 2.2 (c).

The bias voltage for all the ICs in this circuit is 5 volts d.c. This is obtained from a regulated power supply constructed for this purpose. This maximum current drawn by the circuit is 160 mA.

The circuit just described is a mere laboratory model of the system in question. In real application, some modifications will have to be made. The LEDs will, as a matter of necessity, be replaced with filament lamps if the required effect is to be obtained. This makes the incorporation of driving power transistors inevitable.

A housing for the filament lamps will also be constructed to protect the lamps and produce the required effect. The control, which may be microprocessor-based, will also be housed in a box. This box will normally house all other components in the system apart from the lamps.

One should expect that the area where this system would be used might not have access to electricity supply from the national grid (NEPA). A standby generator or a high-capacity battery may therefore be necessary.

2.2 Design and Construction of An Overheating Protection Unit for Electrical Machines.

In March, 1993, a colleague of mine working in a textile company was narrating the happenings in his place of work during the past weeks. A particular case attracted my attention.There was leakage of oil from one of the generators when it's still in service.How the leakage occurred, he could not tell. Expectedly, after working for some time,the generator overheated and got hooked. This incident did not favour the technical staff on duty at the time.

While I wanted to blame the officers on duty for not noticing the leakage,I believed there should be an additional protective device for such a big machine.

Coincidentally, I was supposed to carry out a mini-project in the form of an electronic/electrical design work as part of my Master's degree programme at the University of Lagos. I therefore decided to design and construct an overheating protection unit for electrical devices.

2.2.1 Design Procedures.

The complete schematic diagram of the Overheating Protection Unit is shown in Fig.2.3. The unit consists of three functional sections;the temperature-to-voltage transducer, the switching section and the annunciating section.

The transducer consists of R_2, R_3, RV_1, ZD_1, D_1, R_4, R_5 and the Op Amp configured as a voltage comparator. With $R_2=R_3=4.7K\Omega$, $RV_1=1K\Omega$,and supply voltage=12V,the voltage, V_1 across R_2-RV_1 and R_3-D_1 potential divider is kept at 5.1V by the ZD_1-R_1 arrangement so that a constant current flows in each divider. A constant reference voltage is thus developed between ZD_1-R_1 junction and pin 2 of the Op Amp,and a temperature-dependent voltage with a coefficient of -2mV/°C is developed between ZD_1-R_1 junction and pin 3 of the Op Amp.The value of V_R for the unit to operate at T°C is obtained from equation 2.3:

$$V_R(T) = 0.195 + 2.0*10^{-3}(T-25) \qquad 2.3$$

The switching section consists of R_6,R_7,Q_1,D_2 and the relay. The output V_0 of the comparator is used to drive the transistor circuit. Since this output is either zero or 12V,the transistor is turned on and driven into saturation when V_0 is zero.The voltage across the relay coil is therefore approximately 12V.The coil is energised and its normally-closed contacts opens, cutting off the supply to the electrical machine to be protected (e.g. motor). The transistor Q_1 is 2N3906 which is a PNP transistor and made of silicon.The values of hFE for this transistor is 100.The values of R_5 and R_6 are chosen to be 1.2KΩ and 2.7KΩ respectively.

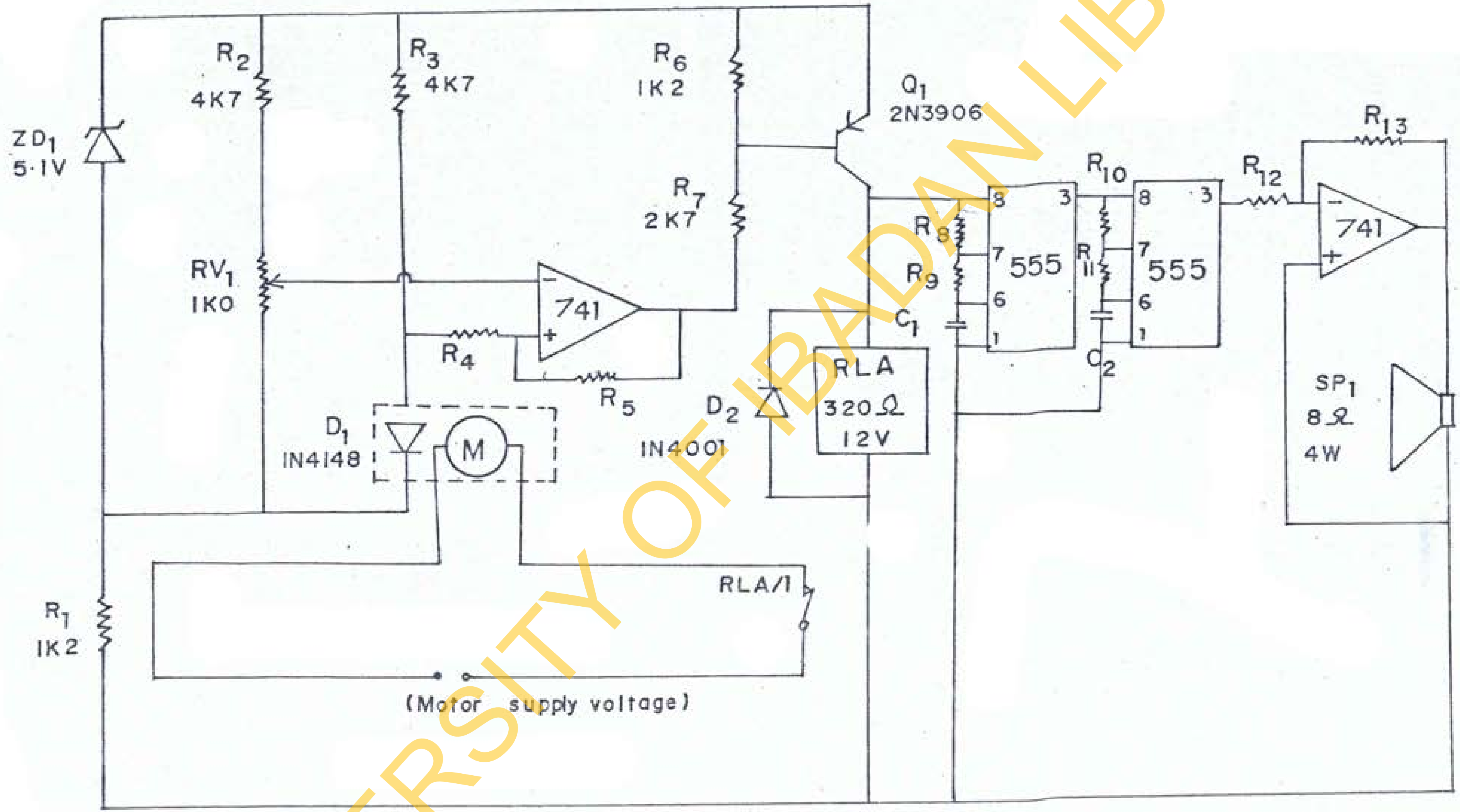


Fig 2·3 Complete schematic diagram of the overheating Protection Unit

These values of R_5 and R_6 will conveniently produce saturation since the coil resistance of the relay used is 320Ω and the annunciating section is of high input impedance.

The annunciating section is essentially a two-stage square wave generator whose output is amplified by the inverting Op Amp to obtain the required signal level. Each stage consists of a 555 timer operating in an Astable mode. The first stage obtains its supply from the output Q_1 and with $R_8=R_9=10K\Omega$ and $C_1=47\mu F$, its output has a frequency of about 1 Hertz. The second stage obtains its supply voltage from the output of the first and with $R_{10}=R_{11}=100K\Omega$, and $C_2=1nF$, an output having a frequency of about 4.8KHz modulated by a signal of frequency of 1 Hertz is produced. The output of the amplifier is then used to drive the 8-Ω loudspeaker which produces the required sound.

2.2.2 Operation

The diode D_1 which is the temperature sensor is embedded in the part of the electrical device which is to be monitored. The level of temperature required to trigger the unit is determined by the setting of RV_1.

If the temperature of the electrical apparatus rises to the preset temperature level of the overheating protection unit, the relay is energised thereby cutting off the power supply to the apparatus to be protected. Simultaneously, the annunciating circuit produces an alarm signal to warn of the overheating condition. When the temperature of the apparatus returns to the normal range, the apparatus may be put back into operation automatically and the alarm stopped. A new temperature level can be set by adjusting RV_1.

The experimental circuit for the overheating protection unit is shown in Fig.2.4. In this circuit, the sensor (diode) was dipped into a can of melting ice to simulate the overheating condition. The potentiometer RV_1 was varied until the relay was just energised, cutting off the supply to the motor and enabling the annunciating circuit. The value of V_R was taken to with a high impedance digital voltmeter and recorded. The corresponding value of

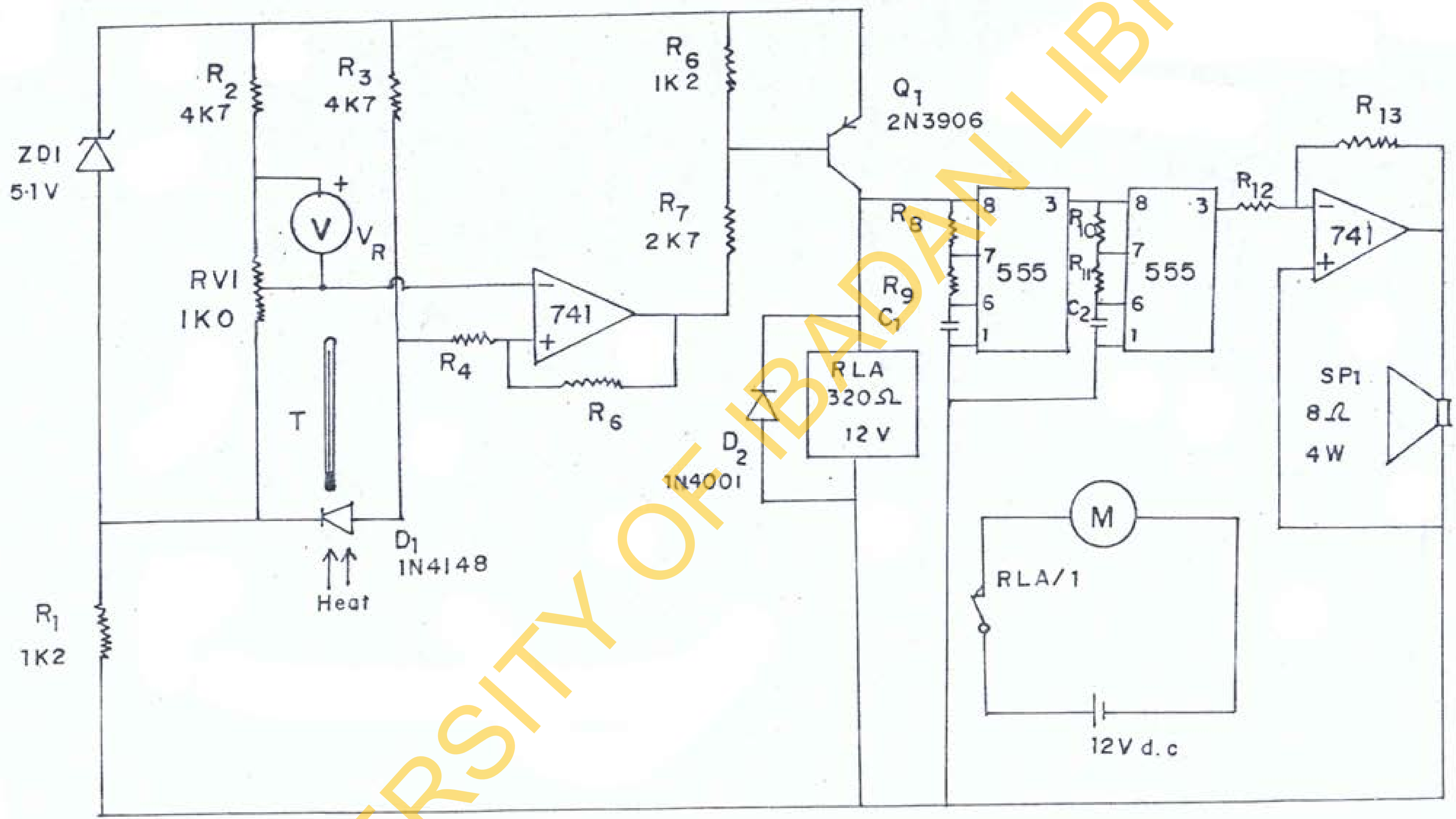


Fig.2·4 Experimental circuit for the Overheating Protection Unit .

the temperature was measured using a mercury-in-glass thermometer and recorded.The temperature of the melting ice was gradually increased and more readings were taken at intervals.To be able to take some readings for temperatures higher than 100°C,the sensor was transferred into sand and was heated vigorously.The readings taken were used in calibrating the voltmeter as a thermometer.With this calibration, it was then possible to preset a trip temperature for the electrical apparatus to be protected against overheating.

2.3 Design and Construction of a Flashing Unit for Traffic Hazard Warning

Early this year, the department got another small consultancy job from an outsider. The job was design and construction of a flashing unit which could serve the purpose of a traffic hazard warner. The unit should be powered by a 12-V d.c. car-battery with a capacity of 56 ampere-hours. The power consumption of this unit should be about 21 Watts or less such that the battery could sustain the unit for a minimum of 32 hours.

This job was assigned to me and with all these specifications in my mind, I came up with the circuit shown in Fig. 2.5.

2.3.1 Description

The unit is basically made up of two astable multivibrators using 55 timers. The two are designed in such a way that they have the same frequency of oscillation. Therefore,

R_1, = R_4 = 10 kΩ, R_2 = R_5 = 10kΩ; C_1 = C_2 = 47μF;

Under normal operation, the ON and OFF time of the first multivibrator are given by;

$t_{ON} = 0.695(R_1+R_2)C_1 = 0.67$ sec.

$t_{OFF} = 0.695R_2C_1 + 0.33$secs.

In this design, it is intended that the ON and OFF times should be approximately equal. Thus, the diode D_1 and D_2 are connected across R_2 and R_5 in a manner shown in Fig. 2.5.

With the previous arrangement, the capacitor C_1 charges through both R_1 and R_2 during the ON time and discharges through R_2 during the OFF time.

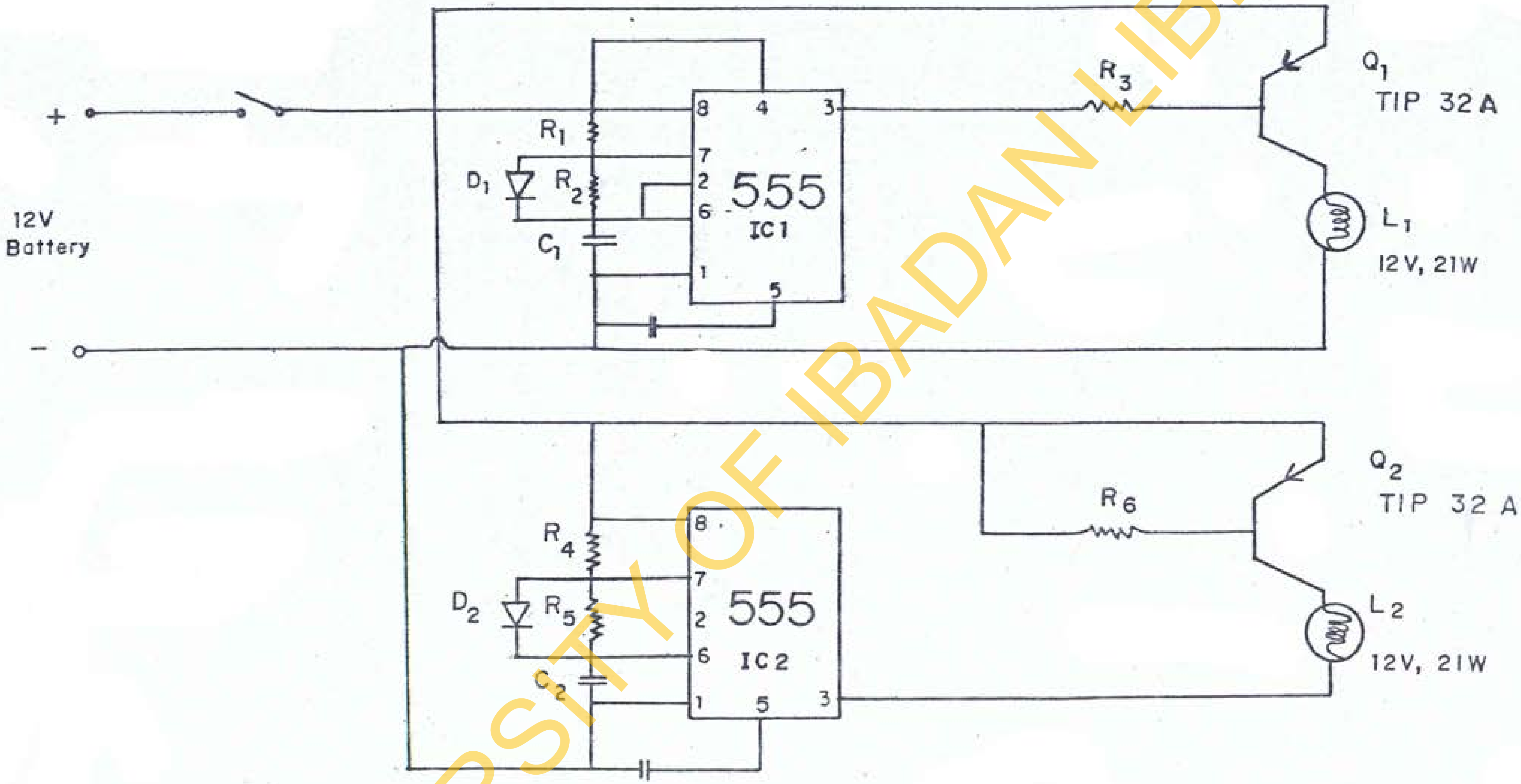


Fig.2.5 Schematic diagram of a flashing unit.

With the diode connected, C_1 now charges through R_1 and D_1 and discharges through R_2. Since R_1 much greater than the diode forward resistance, the ON and OFF times are given as

$$t_{ON} \approx 0.695\ R_1\ C_1 = 0.33 \text{ sec}$$

$$t_{OFF} = 0.695\ R_2\ C_1 = 0.33 \text{ sec}$$

Since a high power application is desired, the output of the 555 timer could not be used to drive the lamps. It is there necessary to use power transistors.

The power transistor driver used is the TIP 32A which is a PNP transistor with the lamp serving as the lead. The maximum collector current for this transistor is 3A and since the lead resistance is about 0.5Ω and Vcc is 12V, the transistor cannot operate safely in the saturation region. It is therefore necessary to limit the current of base current I_B. The minimum hFE for this transistor is 20.

Thus,

$$hFE I_B = I_c$$

$$\therefore I_B = 0.15 \text{ Amperes}$$

$$R_3 = R_6 = 80 \text{ ohms}$$

The values of R_3 and R_6 are taken as 100 ohms for safe operation.

In this design, the output of IC1 serves as the source while that of IC2 serves as the sink. Thus when the lamp L_1 is ON, the lamp L_2 is OFF and vice versa. The output waveform of the lamps L_1 and L_2 in shown in Fig. 2.6. Supervised by me Prof. T. I. Raji [illegible]

2.4 Redesign and Installation of the Public Address System at LAUTECH Theatre Hall

The Theatre Hall is one of the first buildings to be constructed at the permanent site of Ladoke Akintola University of Technology, Ogbomoso. It was later discovered that the public address system installed by the contractor could not serve its purpose.

Towards the end of 1992, the University authority engaged the service of my department in looking at the fault and possibly rectifying it. Almost immediately, a team under my

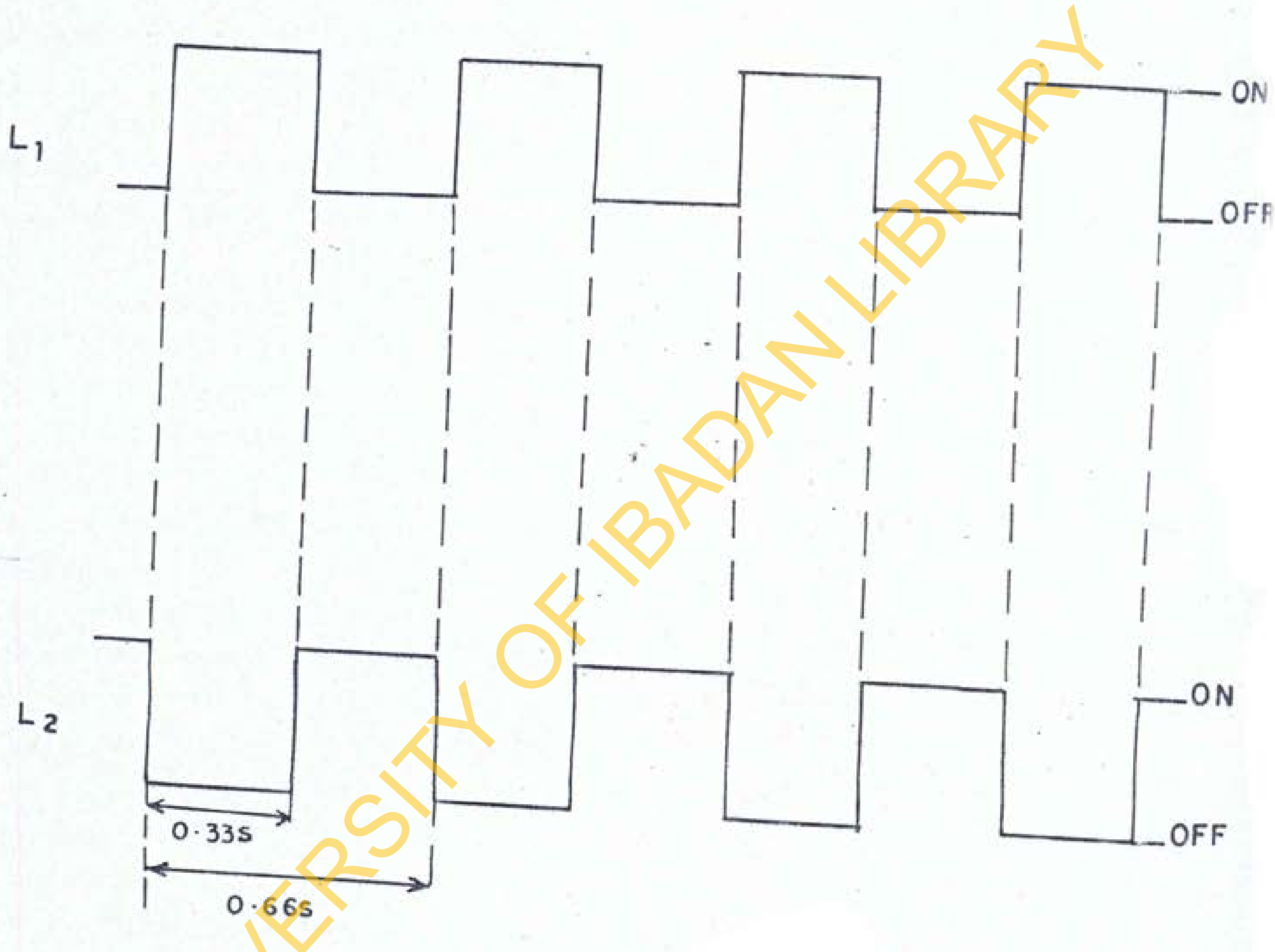


Fig.2·6 Output Waveforms of Lamps L_1 and L_2

leadership was sent to look at the problem. Though no drawing on this system was supplied by the contractor, after some physical and electrical tests, we came up with the circuit of Fig. 2.7.

The three microphone sockets were located on the front wall of the Hall. The cable AA', BB' and CC' which were in conduits ran through the front and side walls to the balcony at the back of the hall. All the nine speakers were mounted on the ceiling of the hall and appropriately spaced. The speakers which were provided with matching transformers were arranged into two channels P and Q.

2.4.1 Fault tracing

After careful study of the wiring system, we decided to carry out some tests on the system to locate the fault.

Using signal generators and d.c. power supply, signals were fed into A, B, C and the outputs were monitored at A', B', C' using voltmetres and cathode ray oscilloscope.

Signals in the audio range were fed into P and Q and the output of the speakers noted.

At the end of the tests, it was discovered that the signal received at A', B' C' were low and distorted and the outputs from the speakers were too low. A careful study revealed that the cables AA', BB' and CC' are 300-Ω flexible type instead of the usual 75-Ω coaxial cable. There was therefore an impedance mismatch between the microphones and amplifier. Also the cables could not withstand the condition of temperature inside the wall. Though the cables $PP_1 - PP_4$ and $QQ_1 - QQ_5$ are of the same type, they were run on top of the ceiling where the condition of temperature was not as bad. It was however discovered that the matching transformers were not appropriate for the 32-ohm loudspeakers used.

2.4.2 Fault clearing

Having discovered the faults, we went ahead to replace the cable AA', BB' and CC' with 75 ohm coaxial cables. This replacement went with some difficulties. Since we had to draw the cables through the conduits which were already embedded inside the walls.

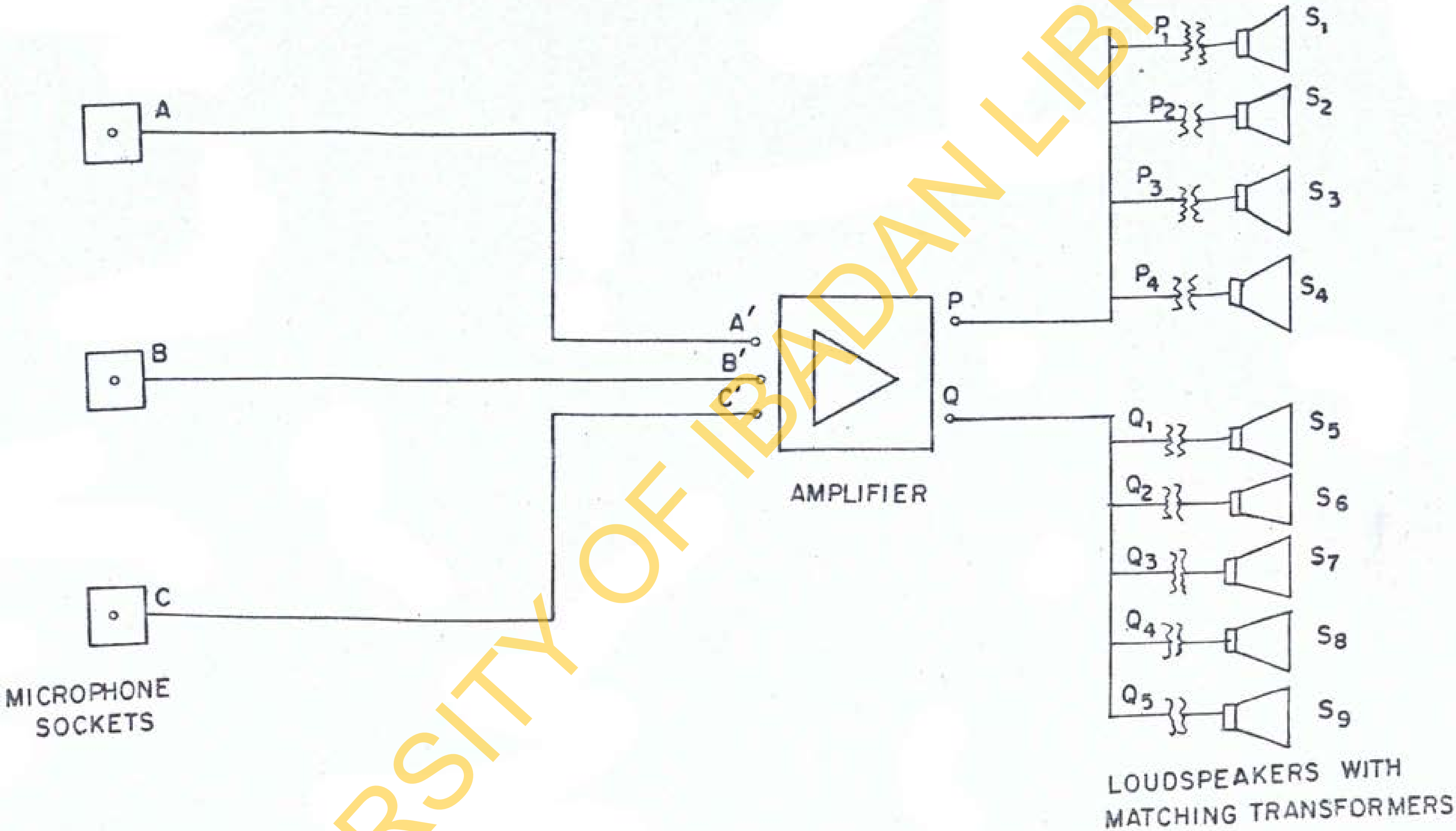


Fig. 2.7 Previous Circuit Arrangement of The Public Address System

All the matching transformers were removed and a new speaker arrangement was designed. This new single channel arrangement has a four-speaker parallel connection and another five-speaker parallel connection. The two parallel arrangements were connected in series. Since each speaker has an impedance of 32 ohm, the effective impedance of the speaker system is about 14.4 ohm. An amplifier with output impedance of 16Ω performed well with this system since they have almost the same impedance values. The new design is shown in Fig. 2.8. Supervised by me Prof. T. I. Raji 27/9/94

2.5 Design of Street Lighting Scheme for Owo Local Government Secretariat Complex

Though I was posted to Owo Local Government to monitor DFRRI project then, I assisted the local government to carry out some electrical projects.

In April 1990, the Works Engineer under whose supervision I was, gave me an assignment to design a street lighting scheme for the premises of the local government secretariat.

Fig. 2.9 shows a sketch of the local government complex. Electricity had already been installed within the premises. The six electrical poles which are shown as crossed-zero in the figure were the existing ones all carrying 3-phase, 4-wire supply arrangement.

After taking necessary measurements, I estimated the number of additional electric poles to be put in place for the purpose of street lighting. The distance between two poles were taken to be about 50 madras. The six additional electric poles to be put in place were shown as crosses in the figure.

Two-wire, single phase wiring was proposed between poles 6-8-9-10-11-12-4. Because of the envisaged developments at site of the workshop, the proposed wiring system between poles 6-7 was 3 phase, 4-wire system. For the purpose of street lighting, an additional line should be between 1-2-3-4-5-6-7 poles.

Considering all these factors, the recommended quantities of materials were estimated.

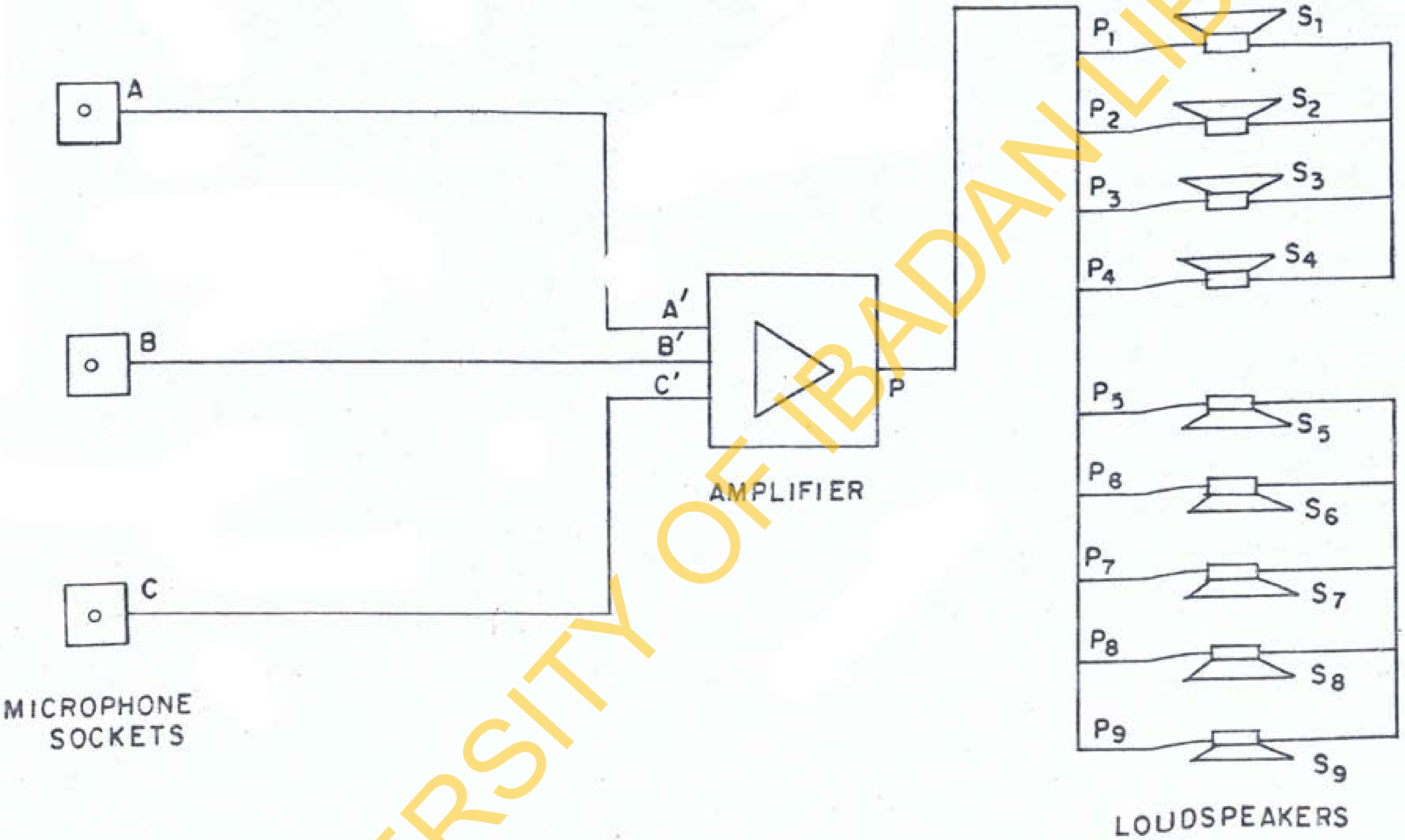


Fig. 2-8 Current Circuit Arrangement of The Public Address System

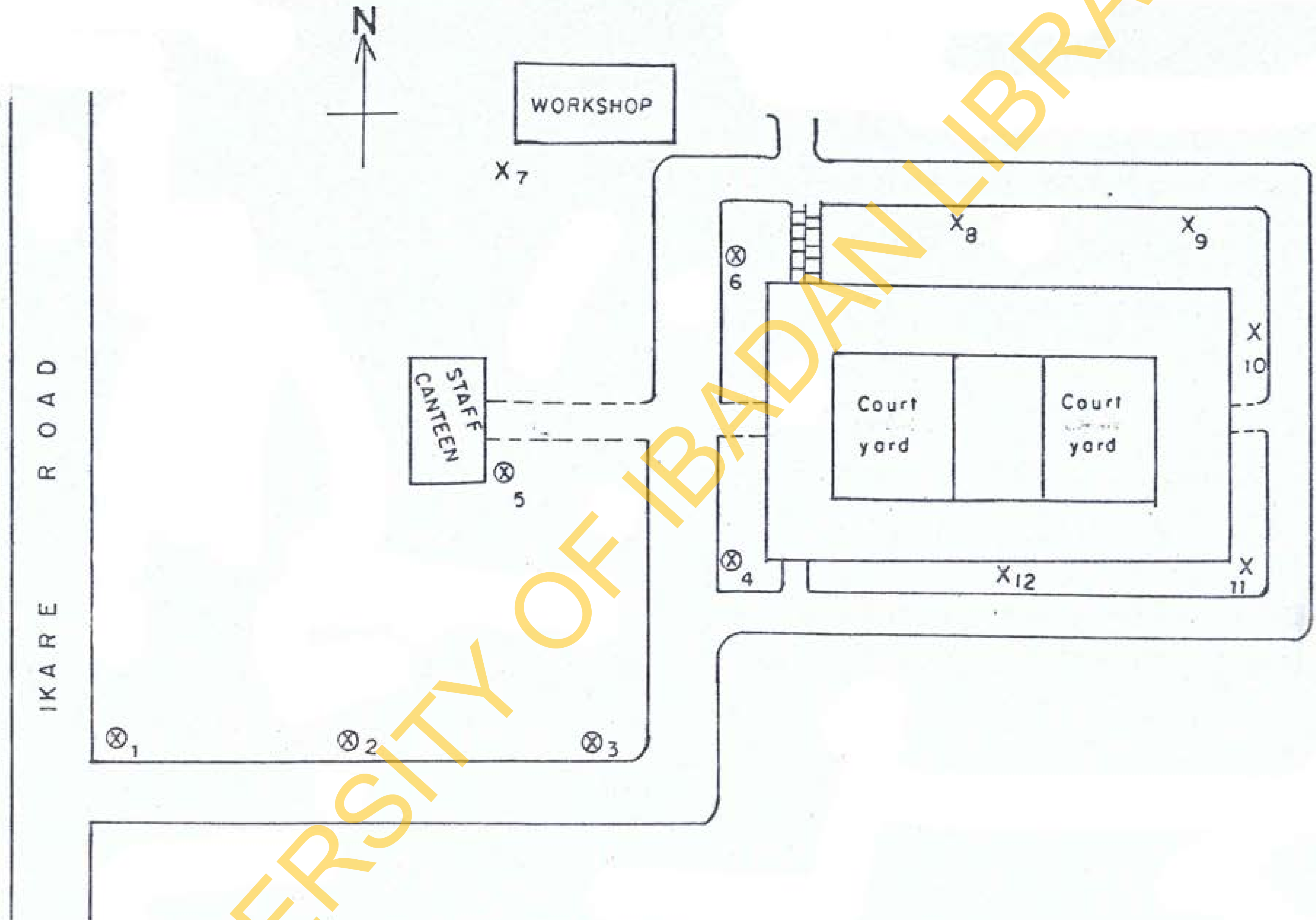


Fig. 2·9 A Sketch of the Secretariat Complex

From various price quotations received, the prices of materials and labour cost were given as follows:

(i) 900 m. of 70mm^2 aluminium cable at ₦9.00 per metre = ₦ 8100

(ii) 6 additional wooden electric poles at ₦1,800.00 each = ₦10,800

(iii) 17 D-Iron Type Porcelain insulator at ₦70 each = ₦ 1,190

(iv) A single-phase Tariff metre = ₦ 250

(v) A 100A-Switchgear = ₦ 680

(vi) 12 complete light fittings consisting of metal bases, halogen lamps and casings at ₦ 1,500 each = ₦ 18,000

(vii) 15 m of 2.5mm^2 copper PVC insulated cable at ₦ 3.50 per metre = ₦52.50

(ix) Cost of labour = ₦ 5,000

Total = ₦44,852.50

III

TEACHING AND RESEARCH

3.1 Teaching

As a Graduate Assistant, I have assisted in teaching and grading of the following undergraduate courses in science and engineering during the periods stated.

(i)	1990/91 - PHY 102	-	General Physics II	(4 units)
(ii)	1991/92 - MEE 201	-	Engineering Drawing I	(2 units)
(iii)	1991/92 - EEE 200	-	Applied Electricity	(3 units)
(iv)	1991/92 - EEE 204	-	Basic Electronics	(2 Units)
(v)	1991/92 - EEE 202	-	Applied Electricity Lab	(1 unit)
(vi)	1991/92 - EEE 206	-	Basic Electronics Lab.	(1 unit)
(vii)	1993/94 - EEE 405	-	Control Engineering	(3 units)

The major problem encountered in carrying out this assignment is the inadequacy of necessary textbooks for both the teacher and the students. The size of the university library and the number of relevant books in it are expectedly proportional to the age of the university itself. To ensure that the students understand the courses very well, I endeavour to give comprehensive notes on the courses I teach. I am from time to time at the mercy of older universities around in preparing lecture notes on these courses.

3.2 Laboratory Administration

The university as its name implies is specifically that of technology. Thus where there is a need to ensure that the students are exposed to a good number of practical works.

In collaboration with a few technical staff in the department. I pioneered the preparation of laboratory manuals during the 1991/93 session. This task I did not find easy since there was the need to reach a compromise between the number and types of equipment available on one hand, and the number and types of practical works desired on the other. Most of the time, I had to adapt an equipment meant for a particular type of experimental work to suit another type. Even some of us in the department sometimes had to bring our personal test equipment and components to the laboratory to ensure that the students had smooth practical sessions.

Even when all these had been done, there was the need to ensure that the students abide by certain laid down precautions and safety rules during the laboratory sessions. We also had to stay around to ensure that they were actually doing what were expected of them.

3.3 Research Activities

Being a young university, Ladoke Akintola University of Technology has not been involved in many research activities especially in the field of engineering. The only research activity I have been involved in at LAUTECH is the one on Solar Generation of Electrical Energy employing Photo-voltaic Cells which is being jointly carried out by the Departments of Electronic and Electrical Engineering, Physics and Architecture. I was among the team that prepared the proposals for the project. The project is expected to take off as soon as the university releases the research fund.

On a personal note, I have been carrying out a research project on Precision Thermistor Thermometer as part of the requirements for the award of an M.Phil. degree in Electrical Engineering at the University of Lagos.

3.4 Participation at Seminar/Workshop

In November 1992, the Department of Electronic and Electrical Engineering where I am a member of staff organised a week-long Workshop on Repair and Maintenance of Electronic/Electrical Equipment for the maintenance staff of local governments in Oyo and Osun State. I addressed the workshop on Troubleshooting.

In November the same year, I attended an international week-long symposium on **Broadcasting in the Nineties.** The symposium, which was held at the Conference Centre, Obafemi Awolowo University, Ile-Ife, was organised by Nigerian Association of Radio Science (NARS).

MAINTENANCE AND REPAIR

Before graduating from Obafemi Awolowo University, Ile-Ife in September, 1989, I had developed a great interest in repair. During my service year, I carried out repairs on a number of electronic/electrical equipment at Owo Local Government Secretariat though my primary assignment was not along that line.

When I completed my National Youth Service in October, 1990, I joined the employment of SMATEK Electronic Services as a Service Engineer. The area of operation of this company were installation, repair and maintenance of electronic/electrical equipment such as generators, motors, radio and TV receivers, Video and Audio Cassette players, typewriters, power amplifiers, equalizers, printers, telephone boxes, electric fans, electric cookers and a host of others. The company also carried out electrical installations on buildings.

My service here exposed me to a new dimension in repair and maintenance. I was introduced to the use of test and measuring instruments which were hitherto unknown to me. These included Cathode Ray Oscilloscope, Pattern Generator, Signal Generator, Mega ohmmeter (MEGA), logic probe, pulser and logic monitor. I also learnt how, when, and where to acquire spare parts for repairs and maintenance of many electronic/electrical equipment without Supervision.

In July, 1991, I joined the Department of Electronic and Electrical Engineering of Ladoke Akintola University of Technology, Ogbomoso as a Graduate Assistant. During the first quarter of 1992, I chaired a committee set up by the Head of Department to look into the possibility of setting up a repair unit in the department. Based on the recommendations of the committee, the Electrical Repair Unit (ERU) was established in May, 1992 and I was appointed as the Co-ordinator. This appointment was probably because of my demonstrated wide range of experience in repair and maintenance. The unit offers its services to both the members of the University community as well as the outsiders. The unit services cover all ranges of electronic and electrical equipment both domestic and commercial.

My duties at ERU were primarily administrative in nature though I was always present at the workshop especially during major repairs or maintenance. I saw to the purchase of tools and basic spare parts. I from time to time reviewed the amount to be charged on repairs as the need arose. I also prepared the statement of account monthly to reflect the income and expenditure of the unit for the month and forwarded same to the Head of Department.

The major problem I face in carrying out my duties in the area of repair and maintenance is the lack of spare parts. To get spare parts sometimes, one has to place orders for them from some overseas countries and with the depreciating value of the national currency, the prices of these spare parts are usually high. Even the ones that are available locally can be so expensive that it is sometimes unreasonable to buy some of them. For instance, a Colour TV was brought to the workshop sometime in 1993 for repair. After careful diagnosis, it was discovered that a 52-pin IC chip was bad and should be replaced. The IC chip cost as much as ₦ 5000.00! How could one explain to a customer who bought his TV set in 1992 at a price less than ₦5000.00 to pay ₦ 5000.00 in 1993 to replace a single chip which was just one of the many chips in the set.

Whenever we can, we improvise some of the spare parts that could not be locally obtained. We also obtain some of them from the available junks!

V

CONCLUSION

Efforts have been made to reveal as much as possible, the professional experience acquired so far. At the same time, I have tried to make the report as brief and as illustrative as possible. It is hoped that the write-up will meet the expectations of the panel.