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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

18137

4th January 1990

CONFIDENTIAL

# REPORT
# BY
# THE UNIDO CONSULTANT IN AUTOMOTIVE SPARE PARTS DEVELOPMENT AND MANUFACTURE

# ON

# ASSESSMENT AND PREFEASIBILITY STUDIES WITH A VIEW TO IDENTIFICATION OF AUTOMOTIVE SPARE PARTS FOR MANUFACTURING IN ANAMBRA STATE OF NIGERIA

BY

S.V. SASTRY
CONSULTANT
"SILICON VALLEY"
29, SIR KRISHNA RAO ROAD
BASAVANAGUDI
BANGALORE-560 004 INDIA

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| POST NO. | UC/NIR/89/173/11-51/J 14101 |
| DURATION | One month and two weeks (including Travel, Briefing, Debriefing and Report preparation) |
| DUTY STATION | ENUGU, ANAMBRA STATE, NIGERIA |
| STAY AT ENUGU | From 17 November 1989<br>To 17 December 1989 |

SUBMITTED TO:- Mr. E. GALAMA
FEASIBILITY STUDIES BRANCH
DEPARTMENT OF INDUSTRIAL OPERATIONS
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
VIENNA INTERNATIONAL CENTER
VIENNA - AUSTRIA

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# THE ASSESSMENT-AND-PREFEASIBILITY-STUDY-REPORT BY UNIDO CONSULTANT - Mr. S.V. SASTRY, ON MANUFACTURING OF SELECTED AUTOMOTIVE SPARE PARTS IN ANAMBRA STATE OF NIGERIA.

## 0.00 SUMMARY

The Consultant reached Enugu, capital of Anambra State, after due briefing at UNIDO, Vienna and UNDP, Lagos, on 17th November 1989 and was received at M/s. Central Investment Co. Ltd., and was introduced to both the Commissioner and the Director General, Ministry of Commerce and Industry, Anambra State. The field work commenced immediately. consisting of study of data, visits, formal and informal discussions, formal and informal interviews, collection and collation of data and information of pertinence and relavance to the job description, serving as a basic input into the joint work with Mr. E. Galama of Feasibility Studies Branch of UNIDO, Vienna who arrived at Enugu on the evening of 7th December 1989. The Report dated 15th December 1989 on Terms of Reference for Five Feasibility Studies on Manufacture of Selected Automotive Spare Parts by Mr. E. Galama contains/incorporates, the summary, digests and conclusions of various studies and field work conducted by Expert/Consultant prior to arrival of Mr. E. Galama, at Enugu; therein it covers all aspects of the job description given to him. In particular the summary and conclusions have been incorporated in items A and C of the Report dated 15th December 1989, cited before

This is a separate Report by the Expert Consultant which is essentially:- (a) Supplementary to the inputs given to Mr. E.Galama and those of which have been incorporated in the above report dated 15th December 1989 by Mr. E. Galama, (b) Engineering oriented, industry oriented, technology oriented plus also dwelling on subject of certain characteristic features of automotive spare parts' trade and marketing from different points of view and hence, imparting into the auto parts market the real time equilibria, (c) Incorporating the backward and forward linkages, both industrial and technological; plus horizontal and vertical integration perspectives (d) The "Quality Angle", (e) Support facilities and support systems that can be seeded into, or rooted into existing/ongoing nuclii, (f) Filling missing links, (g) Information and ideas likely to be of interest to future feasibility studies.

Thus, this Report is a Supplementary Report to the one prepared by the Unido Official at Enugu with inputs continuously given by the Consultant into the report compilation processes. Thus, both of these, ipso facto, integrate into each other; and the economic and technological considerations and constraints operating on the project, meant to give birth five spare parts industries; which in turn are meant to usher in many more in their wake.

This Report covers all aspects of job description and duties. But the order and style of presentation are some what different in order to impart better degrees of homogenuity and continuity.

Furthermore, it is also note worthy that compulsions of local and national parameters which were found, during the study, to be operating on the segment of industry, now under study, are such that, that not all the items indicated in the items of reference contained in Job Description dated 11 August 1989 have equal importance vis-a-vis the role of the Consultant; whereas, in some other areas, it was found, extra information and inputs by the Consultant would be useful and necessary. Both these aspects have been taken into account while formulating and compiling and presenting this Report.

This Report, in itself, is homogeneous. Homogenuity implies some desegregation and certain degrees of overlapping and repetitions. Nevertheless, it has to perforce be divided into parts, though not into compartments. The various areas and items dealt with are:

(1) Automotive spare parts and their manufacture,

(2) Information on local facilities, constrants, opportunities and realities to recon with for the establishment of auto spare-parts industry in Anambra State, gathered during the field work,

(3) Method followed for arriving the recommended 10 candidate industries, (4) Projections, justifications, weightages, (5) Notes on products and their technologies and illustrations, (6) Chronological narration of work done which also indicates the process by list of 10 selected industries was arrived at (7) List of officials met

(8) References.

# PREFEASIBILITY ASSESSMENT REPORT ON SELECTED AUTOMOTIVE SPARE PARTS MANUFACTURE IN THE STATE OF ANAMBRA, NIGERIA

BY

S.V. SASTRY

CONSULTANT TO UNIDO PROJECT UC/NIR/89/173/

11-51/J-14101

## 1.0.0 AUTOMOTIVE SPARE PARTS AND THEIR MANUFACTURE

1.1.0 Vehicle classification in its relavance to Spare Parts: Definition of, "Automotive"

SAE, Society of Automotive Engineers, U.S.A. classifies vehicles in two broad classifications; i) Highway Vehicles and ii) Off Highway Vehicles. Off highwayvehicles include, snow-mobiles and earthmoving equipment, as a matter of illustrative examples. Coming as it does from U.S.A., two and three wheeler vehicles, do not find any special mention. Non-automotive diesel engines generally are under the umbrella of off highway vehicles. A variety of large agricultural vehicles also come under this category. Excepting in insecticide sprayers, small portable gensets, concrete vibrators and out board motors, petrol engines invariably form a part of the vehicle; in contrast to the diesel engine. One basic type of diesel engine with certain add ons may go on a commercial vehicles, bus, stationery

industrial application, generator sets, tractors, coastal marine craft for fishing etc.

A more detailed classification which attempts to categorise automotive vehicles is as follows:-

1. Heavy commercial vehicles including tractor trailer combinations for highway haulage on modern roads.
2. Medium duty commercial vehicles for state level highways including in city and inter city haulage/trucks/lorries.
3. Light commercial vehicles/LCVs, petrol and diesel.
4. Buses for mass transport systems, inter city and intra city.
5. Mini Buses
6. Passenger cars
7. Two and three wheelers
8. Tractors
9. Diesel engines.

In case of tractors, the tractor vehicle and engine are considered automotive, upto p.t.o; whatever comes after the p.t.o. is classified under agricultural machinery and implements. Diesel engines are generally taken under 'automotive' irrespective of end use because of the nature of components (excluding larger larger engines for railway, marines etc). The running thread in the classifications is the technology - component and, the trade-component.

Pistons, bearings, valves, shock absorbers are some examples. If we take this into account, what follows next is the obvious. In later parts we have taken into consideration only a percentage of a conservatively estimated demand for spare parts. This means, that when the entrepreneur perceives that his market share could be much more, he can deploy product mixes within his industry to maximise the net gain. This aspect does not yet seem to have been sufficiently highlighted in the draft Opportunity Studies Report of Baldo.

In case of Nigeria, population of three wheelers, mopeds, scooters appear notional. There is a good presence of motor cycles especially, outside the major cities. The presence of automotive diesel vehicles in Nigeria at present is not very conspicuous. However reports dealing with the future of transportation, underline the envisaged trend to introduce diesel buses. Well documented trends for the passenger car industry plus the indicated allocations for diesel buses point out towards higher dieselization by the time the projected auto spare parts industries come on stream. The auto component industry that caters to diesel vehicles can handle the manufacture of components for passenger cars even though the converse cannot always be taken for granted. Another factor that has the potential to become a parameter for improving the demand pattern, is the growth of taxi industry. Slump in the demand for passenger cars is popularly attributed to initial high prices of the personally owned passenger cars. The same car could become a good investment as a taxi. This parameter

is very well within the purview of banks and local and regional authorities. This factor has not been introduced here as an extraneous issue. This is because taxi is a social industry or a community industry and where the load factors are higher, wear and tear are higher, where the number of hours of down time is very much more expensive as it is linked with the earning rate and therefore is an industry that has potential for higher off take of (a) spares, (b) high quality spares. These are implied-linkages which cannot lend themselves to uncomplicated rapid quantization at present but could be left to the entrepreneural skills of the potential investors.

There is a sizeable population of motor cycles operating away from major cities and where road conditions are mediocre to bad. Since the idea in demand estimate has been to bring out the viability of a veryconservative demand estimate, no weightage has been assigned also to this potential node of profitability.

## 1.2.0 AUTOMOTIVE PARTS, AUTOMOTIVE ANCILLARIES, AUTOMOTIVE COMPONENTS, AUTOMOTIVE SPARE PARTS.

In this section it is proposed to arrive at a broad understanding of the area coming under the classification of "automotive spare parts".

In general, a vehicle consists of following groups of parts, grouped according to concerned functional parameters. They are sub-systems; and the total performance, quality and reliability of the vehicle depend on

individual subsystem performances. Sub-system performance depends on component performance in its relevant working environment within the totality of the man-machine system, which is the vehicle. The vehicle itself is a part of transportation system which operates in a social and public environment. Taking sub-system performance as a criteria, one typical basic classification is as follows: (The example chosen is that of a medium commercial vehicle and bus)

i) Engine, (ii) Engine cooling system, iii) Engine Lubricating oil system, iv) Engine Electrical System, v) Engine Fuel System, vi) Clutch, vii) Transmission, viii) Front axle/ Front suspension, ix) Rear axle, x) Propeller shaft, xi) Braking system, xii) Steering system, xiii) Electrical system.

These are meant to illustrate method of grouping. In case of passenger cars, there are different suspension systems and engine mountings and drives. In case of passenger cars, the main sheet metal body is a load bearing structure unlike that of a bus, for example; a good percentage of auto electricals form part of safety items and have statutory implications. Items connected with emmission regulation are out of the purview of present study. Trim, ornamental, decorative items are generally not considered. Comfort items also are not considered, however ergonomic items are design parameters.

### 1.2.1 PART NUMBERING

In an automobile manufacturing industry each part has a name, a drawing and a number. There are what are known as master lists which contain all relevant data for planning, manufacture, costing, ordering, inventory control and assembly. There are sub-assembly drawings, sub-assembly drawing numbers and sub-assembly part numbers. There are part numbers for proprietory items. There are part numbers for what are known as standard parts. Standard parts may conform to company standards or national standards; company standards where only dimensions are concerned are generally for inventory and cost control. Part numbering follow codes laid down by the company standard for numbering designed for easy identification by concerned technical staff.

Amongst the various sys-systems that go into the assembly of a vehicle, there are several items made by established suppliers or vendors, because a vehicle manufacturer generally concentrates on manufacture of major aggregates and the total product. In certain cases, especially in commercial vehicle or buses, even major aggregates may be bought out (eg., Cummins Engines, Timken axles etc). It depends on economics and superior performance. Fuel injection equipment, spark plugs, shock absorbers, clutches, braking system, head lamps, filters, radiators, steering assemblies, piston assemblies, bearings and bushes, are examples of bought out items. Vehicle manufacturers prefer a net work of ancillary industries because development and tooling costs are dispersed and, results in increased induction of more sophisticated specialised know how

and technology. In such cases, cost will be less if it is bought out from a specialist ancillary suppliers or, vendors. Some vendors may be small: some may be captive units; some may be small in size but world famous; some may be very well known multi-nationals - Bosch, Lucas etc. When these are supplied to vehicle manufacturers (OE) they are ancillary items or fall into category of auto ancillaries. The same items when they are sold in the open replacement market, they are called automotive spares. Auto ancillaries themselves may be dependent upon their sub-contractors to whom the ancillary manufacturer is the OE. Replacement market or spare parts trade is a very important segment for both the OE and the ancillary manufacturers. Part numbers or drawing numbers described earlier are meant for design, planning, procurement, inventory control, production and similar in-plant activities. They are numbered differently and periodically undergo modifications for a variety of reasons which are fully documented on the drawings and master lists. Part numbers change only when there is sufficient justification. Obsolete drawings are recalled and destroyed. Spare parts in the replacement market are sold by name and spare part number. Spare part numbers are not same as part numbers or drawing numbers contained in master lists. But there are systematic documentation establishing the correlation with drawing or part number. Whenever a modification is effected or part number is changed, it is compulsory at the drawing office level to have it documented properly whether the interchangeability fitment and performance vis-a-vis to function as a spare part is affected or not. This will be a guiding factor in determining whether spare part number is to be changed or not.

In all these line functions communication channels are well established. Computerization and microfiche have been making in roads into all these activities. In Enugu, Levantis for Mercedes Benz and Tractor and Equipment Division of UAC of Nigeria Ltd., for Caterpillar use microfiche in their spare parts and service depots.

These are a few elementary factors that are at the foot steps of the sprawling auto ancillary/component/spare-parts industry and trade, generally called the replacement market. Replacement market carries inventories of models not in current production. OEM do not. In fact residuary inventories of OEM may be shifted over to replacement market when there are good reasons to do so.

Inventory control in replacement market is thus a very much more refined art of the trade, than inventory control at OEM which is but one more more branch of industrial engineering. Spare part dealers have the know how to shuffle the inventory and price mark ups. In the regulated spare parts dealerships, the pricing is pre-determined; wh as in the open market the prices are subject to the usual market forces.

## 1.3.0 CATEGORIES OF AUTO SPARES

1.3.1 **Original Spares:** These are the ones marked by the vehicle manufacturer under his name and his dealer network at prices formally determined by him. The manufacturer guarantees the quality. All

warranties and guarantees stand annuled if these original spares are not used. Their prices are also higher. In a number of cases these "original spares" are products of reputed ancillary manufacturers for example spark plugs, fuel injection parts, pistons, bearings, oil seals etc.

1.3.2 **BRANDED SPARES:** There are manufacturers of ancillaries who are not only suppliers to OE but who have a brand name which is as good or even better known than OE. They sell spares on their own name and part number. Since OEM, as a rule, have more than one supplier of ancillary equipment and each may be marketing on their own in the replacement market, there exist catalogues which give the various equivalent part numbers. These brand names are so strong and so well established for quality that OEM cannot and do not raise any doubts. These manufacturers will also have partook in the product development of the OE with their own R & D resources. These have the further advantage that they have access to the detailed data sheets quality standards of the OE. These parts' manufacturers also cover the spare parts requirements of bulk consumers of spares like fleets because they can sell at prices which do not include the margin of the OEM.

1.3.3 **BRANDED SPARES MADE FOR REPLACEMENT MARKET ONLY:** These are made and sold by spare parts manufacturer without direct link or support to the OE. They depend solely on the replacement market. They stand on their own name and reputation. Of course they cannot prevent a new OE from one country or the other, approaching them.

However, they build up their market reputation based on their own technical, R & D and marketing skills. Here the marketing at grass roots level becomes very important because the assurance that the consumer needs, is given by the retailer, the garage and, the mechanic. Continuous consumer satisfaction becomes the foundation for the industry. They advertise and thrive on their own technical and marketing strengths.

1.3.4 **SPURIOUS SPARES:** Spurious spares are of two categories.

a) Good spares made by manufacturers who have skills and identity but who are either of medium scale or of medium financial strengths, medium objectives. They will have put in good effort to build in quality so that they stay in the market. They often copy intelligently.

b) Spurious spares made by little known small scale manufacturers who copy mostly from the point of fitment and scant considerations of quality requirements, often ignoring basic raw material considerations and sell it to bulk purchasers in the unorganized sector of auto spares. The outlet to the customer is through the way side mechanics when the vehicle owner wants a quick fix. These spurious spares are made, sold and bought at individual's risks and there are no significant institutional involvement.

1.4.0 **O.E.M. ACCEPTANCE:** Original Equipment Manufacturers are interested in Vendor Development. Vendors are those that supplythe ancillaries. Generally suppliers of consumables, tools, raw materials are

not included in this category. OEM are also interested in development of more than one source of supply on grounds of reliability of supply lines and logistics. OEM do not wish to carry big inventories of ancillaries. There are some popularly quoted examples of sub-contracted items being loaded straight on to the conveyor lines without even detailed inspection at the receiving end. In case of Anamco in Enugu the time lapse between ordering, L/C opening and receiving on site was reported as 9 months during which time, the money is locked up. As a part of vendor development activity, the OEM also supply to the vendors the classified drawings, specifications, data sheets and acceptance standards and similar documentation to genuine vendors of dependable credentials and/or track record. These are ip so facto on conservative basis, because data and documentation are classified and are prone to be misused. In certain genuine cases the OE development engineers visit the vendors' works and teach and pass on the knowhow. OE acceptance and OE ordering schedules are important supporting documents for banks also. OE acceptance is a fairly lengthy procedure, even for a vendor next door. First is the sample submission and acceptance of the sample. There is the dimensional inspection, fitment tests, materials testing, testing for performance and reliability in R & D labs and on test tracks and in road tests. Then comes the quality conformance tests. Inspection of vendors works to verify the competance to match the qualities of the approved example in bulk supply. The samples have to queue up along with other samples awaiting approval. There is also the overall judgement exercised at various decision making layers where, by and large, the benefit of doubt is not passed on to the vendor unless the stature is

so high as to warrant a debate and discussion process. When in doubt the consumer is protected. Vendor is not protected when interests do not coincide. OE acceptance procedures are often misunderstood and misinterpreted complaints lodged and motives imputed especially when vendors are not strong or not mature. For a component manufacturer it should be a part of his investment to cultivate the engineers of OEM on technological terms and satisfy them that he does not shurk from his portion of work. In developing countries the vendors should be able to organise a maximum number of tests possible at local and national levels before samples are taken for evaluation at the R & D labs of parent factory. There are several methods available to make this process less ardous than it appears at first sight, provided there is will and perseverance required to enter the product line and stay there. This includes faith in technologically qualified and amply motivated indegenous engineers and extending full support to their training and initiative spirits.

1.4.1 OE sample acceptance is the first step but a big leap. Then comes the quality conformance. OEM have to take upon them entire burden of underwriting the Quality of the Total Product; notwithstanding who made the component; big or small. There is the further burden that if there is rejection due to a faulty component at any point of "stage inspection" and the sub-assembly itself may get rejected because of one faulty part. This is because the man hours in fault location and reworking may be more expensive than the price of the component itself. If the rejection occurs at final stage or when product is approaching final inspection, the loss

due to rectification of vehicle in the sick bay not only consumes paid-for man hours but also represents the capital locked up for the period, because, ideally, the time lapse between final approval of the vehicle and its sale, is only the transit time from assembly line to dealers' delivery point.

There are various methods followed in different countries and different companies to ensure quality conformance. Innovations are a part of this discipline. Statistical quality control was the first, but a fairly ancient, scientific technique. More recently concepts such as "Zero Defect". "Quality Circles" etc have attracted international attention. Ideally, the part or sub-assembly arrives in time at the works to be loaded to the conveyor that moves on to the point at which it is assembled and becomes a part of the vehicle.

There always is a functional group within every Quality and Reliability Department called "Goods Inward Inspection", in order to intercept and reject before a part or sub-assembly is taken into stock; i.e. becomes eligible for payment. This GII function and size varies from situation to situation, company to company, supplier to supplier. Quality and Reliability Departments are headed by Vice Presidents ranking on par with every other Vice President. Quality Control departments and personnel are not answerable to production departments. They seek assistance of and work in collaboration with R & D and may also possess their own quality control labs consisting of test rigs, metrology, chemical and matallurgical lab facilities. They are helpful to vendors but are guided by the company

norms. A component manufacturer has to establish himself and be accepted by the Quality and Reliability Departments. Sample acceptance does not automatically mean order placement or placement of regular delivery schedules.

1.4.2 Another criteria to become an OE supplier is strict adherence to delivery schedule. The agreed quantity of approved components have to be delivered on time because assembly line hold ups due to parts shortages are just not accepted by manufacturers tuned to current day mass production techniques. OEM also have in-built buffers to take care of disruption to supply lines due to factors such as industrial unrest etc.

It may not be out of place here to take notice of the fact that increased levels of automation are the creed of the day in automobile industry. The parent companies of the Nigerian Vehicle producers are also expected to be under well defined pressures from a) emmission and fuel economy regulations, (b) microprocessor revolution which is on the door steps of product design and development in the shape of vehicle and engine management systems.

These aspects have been dwelt upon to underline the entreprenueral responsibilities implicit in decisions to invest in the auto component industry.

1.4.3 Prices offered by OEM to parts manufacturers are not the prices at which parts are sold in the spare parts market. In fact it may be far from it. The supplier in turn gains from his credibility in the market and an assured off take.

1.4.4 These are some of the reasons why auto component manufacturers have to, in fact do, bend back to gain OE acceptance while trying concurrently to push up their share in the replacement market. Component manufacturers have to bear their own tooling and development costs. These aspects will figure again when dealing with subjects such as collaborations, common facilities etc.

1.4.5 These are some of the main reasons that have entered the quantization process and exercises that have gone into arriving at the recommended installed capacities for selected list of automotive spare parts in this report. The recommendations are that components manufacturer shall try to qualify himself to become a OE supplier to meet a modest percentage of OE requirements. Whereas it is academical to insist that OE shall have only indigenous vendors it is in OEs own enlightened self interest to promote vigorous indigenous vendor development programmes. It is in this context progressive role of various governmental agencies, ministries, financial institutions, planners and economists come in. While inducting a new category of industry, it is most desirable to be conciously aware of the parameters which influence the safety of the capital deployed and, the profitability.

Here it will be interesting to take note of the implied wisdom in the letter from the Hon'ble Commissioner for Ministry of Commerce and Industry Mr. D.N. Ongele, Anambra State, Nigeria to Director General of UNIDO, wherein the proposed feasibility studies are framed in the context of Government's programmes for mass transportation, agricultural produce distribution, foreign exchange conservation. Thus, the letter has wisely noted that envisaged feasibility studies should serve as pilot and demonstration exercises. In the same context, it is worth recalling a passing remark made cn 8th December 1989 by Mr. C.O.Udoye, Director General, Ministry of Commerce and Industry, about their interest and concern for engaging and involving the Nigerian qualified young engineers in manufacturing industries such as those under consideration here.

## 1.5.0 APPROPRIATE TECHNOLOGY:

It is in the context of these that the Appropriate Technology has to be examined. Some times the expression is synonimously used with Intrmediate Technology. Appropriate Technology varies from country to country and industry to industry. However, what is common is its pragmatic and flexible approach, without any subjective santimoniousness attached to what may have succeeded elsewhere. Developing countries have taken time and learnt through expensive experiences over the past four decades that appropriate technology or intermediate technologies are not things about which one has to be apolegetic but are necessary to succeed. Appropriate Technology/Intermediate Technology have as their allies, "Reverse Engineering", "Value Engineering", "OE-Vendor Education",

"Import Substitution Engineering" and, from case to case, sympathetic foreign collaboration. It is a whole process of synthesization and depends on native genius, innovation and initiatives and courage. Import substitution as a branch of Intermediate Technology has come to stay in developing countries. Appropriate Technology can be proved only in the crucible of indigenous success. Appropriate Technology is not a cliche; nor invitation for softer options. An outsider cannot give prescriptions for Appropriate Technology. A new and emergent dimension to the concept of appropriate technology is the incipient trends observed in industrialised countries with escalating wage rates, to assess "Buy-back schemes" on merits. Thus, appropriate technology becomes a new discipline of synthesis in product evolution programmes. A later day start could be turned into an asset rather than a handicap. Intermediate Technology also calls forth leadership qualities to lead indigenous talent. Tool Engineers and Tool Rooms are pivotal in evolving appropriate technologies. Process Technologies, Metal Working Technologies, Tool Engineering, Methods Engineering, Industrial Engineering. These form one chain. In the context of emergent Nigerian auto component industry, Quality Control Engineers, Quality Control Supervisors, have to be trained and kept continuously educated in modern thoughts and practices in Quality and Reliability Engineering. All the above aspects have implications to investments and cost of production and therefore viability of industries under consideration.

## 1.6.0 INDIGENOUS ENGINEERING TALENT ANDMANPOWER

This topic is a sequel to concept of appropriate technology. Considerable field work was covered by the present Consultant in this area. It is widely known that Anambra State and Enugu area has produced a very good number of talented engineers. A very sizeable proportion having received degrees from well knowr academical institutions of Western Europe, U.K. in particular. It is stated that talented engineers from the region are spread out in many parts of Nigeria in quest of career opportunities. Nigerian Engineering Colleges also turn out bright engineers. Not many of these above categories of engineers it appears have been exposed to the vigorous practical training in mechanical engineering and metal working industries and tool rooms in general and auto ancillary industries in particular. This gap is identified and needs to be filled up by interested institutional support.

There have been references in other reports on Nigerian industries about the paucity of foundries and forge shops. Automotive Industry is a typical mechanical engineering industry. Foundry requires skilled pattern makers and core shops. Pattern making starts with wood working/carpentry skills and intuitive feel for flow of molten metals. There are various cold metal working processes. Turning, milling, drilling, boring, grinding, jig boring, tool making, die making, tool assembly and fitting are some of the skills required. Apart from these, the workmen need to know blue print reading, ideas of fits and tolerances, use of measuring instruments and gauges. Heat treatment and knowledge

of metallurgy, metallography and interpretation of metallographic data are also essential to mechanical engineering industry. The other category is the machine operators and tool setters. As we go along we come across die casting and press operators. It is just not the ability to operate the machines, but it is the skill required to minimise the rejection rate that is decisive in cost of production. Supervisory skills are vital. They have to be created and sustained. It was the general experience during field work to come across statements about the very skilled local auto mechanics who can repair vehicles. When it is a question of auto parts industry, the motor mechanics are not conspicuously in the manufacturing picture. It is the various categories of skilled machine operators, tool setters, inspectors and supervisors and foreman who carry out the direct production operations.

There are also sufficient references in various reports to the various large Nigerian projects involving steel, steel and smelting. They are all understood to be in various phases of going-on-stream sooner or a little later; may be with some teething problems. But they are there to stay.

During field work and studies, it has not been possible for the Consultant to come across references to tool rooms and heat treatment facilities. Whichever auto component industry one may opt to study, it may at very best-start with one set of imported jigs, fixtures, guages and dies and punches, but these are not items which can be continuously imported. In fact importing of jigs, fixtures, gauges, dies, punches etc.,

are harmful. Dependence on imported toolings is worse than dependence on imported components. Tool Making, Tool Design, Heat Treatment, Interpretation of Metallographic data are skills that have to be rapidly positioned. Auto component industries have to have Tool Design, Tool Room, Heat Treatment sections of appropriate size. As things appear today, with resources already in situ, the highly motivated qualified and talented young engineers presently positioned in academical positions are a natural reservoir of candidates for being inducted into the new industries coming under the purview of the current study. They have to be foretold in advance of their opportunities and responsibilities and put through intensive practical training wherever the practical training of the type required is available. That means that proceeding for training to a plant with very high rates of production, automation etc., may not be optimum for mastering the appropriate technologies to be deployed on returning to Nigeria. This topic will be discussed again under the narrations of field work done.

## 1.7.0 STANDARDIZATION, TECHNICAL DOCUMENTATION, PUBLISHED TECHNOLOGICAL INFORMATION:

Today, a vast volume of technological data is available as published standards coming from many countries. DIN, ASTM, SAE, BS, ISO are examples. Because of sheer magnitude of automotive industry it is unreasonable to expect that one single source to cover all data that is required for automotive manufacturing technology. Nonetheless, if

sufficient efforts are made it is possible to assemble the most significant portion of technological information and data required for the automotive components industry. Furthermore the ancillary manufacturing industries in highly industrialised countries have published data as a part of sales engineering efforts. There is also a continuous output of technological information in the technical journals. It is but prudent to harness these internationally available technological data banks while evolving techniques of intermediate or appropriate technological strategies. Nigerian Standards Organization is an on going National Institution with also a sizable and vigorous branch at Enugu. They have also a Quality Marking Scheme which, however, is still to enter the field of automotive engineering. Nigerian Standards Organisation branch at Enugu can access any published standard anywhere in the world. That is the methodology practiced by fraternity of International Standards Organisations. When a manufacturer declares conformance to SAE, DIN etc., standards, the credibility coefficient increases. It makes the dialogue with OEM easier and smoother. It is recommended that multi pronged efforts be launched to rapidly build up data banks of published standards and technological data at Enugu branch of Nigerian Standards Organization. This aspect will figure again while narrating the field work done by the Consultant.

## 1.8.0 AUTO SPARES/AUTO COMPONENTS - A CLARIFICATION

It is customary to exclude the following vital components of automotive vehicles from formal definition of auto ancillaries sold to OE and in replacement market because they come from highly organized large industries which serve also other sectors of industry and economy.

Tyres and Tubes, Batteries, Ball and Roller Bearings, 2D Plate Glass. Since these and similar items form significant cost of production, some times they are bracketed with the indigenous content of a vehicle. If this particular aspect is understood, it will be easier to interpret the statistical information about indigenous content.

1.9.0 In summary, this chapter has dealt with the following aspects in the Nigerian and Anambran context: Auto components, spares, OE supplies, quality assurance, intermediate or appropriate technology, tool rooms and tool engineering, technical man power, standardization. This background information is conceived as an input to the envisaged feasibility studies and form part of report of the prefeasibility studies of the present Preparatory Assistance Mission.

## 2.0.0 STUDIES, FIELD WORK, VISITS, FORMAL AND INFORMAL MEETINGS - A NARRATIVE DIARY.

On arrival at Enugu on Friday 17th November I went to offices of M/s. C.I.C. and met Mr. Vin. O.C.Uzowulu, Deputy Controller, Project Development Department, C.I.C. and Engr. Chris. C. Nkwonta, General Manager, C.I.C; thereafter at the Ministry of Commerce and Industry, Commissioner Mr. Daniel Nwagu Ongele and Director General Mr. Cyril Udoye. The Commissioner informed me that persons connected with the project had proceeded to Lagos and will have a meeting on Monday. I met Mr. Uzowulu informally and Mr. Uzowulu gave an account of working of C.I.C. and their consultancy activities. There was a brief discussion on Baldo Report for NIDB; but Mr. Uzowulu was not conversant with it. On the question of partial imports during the period of indegenization, Mr.Uzowulu's opinion was that if 50% foreign investment were to be there, then it would be easier to introduce progressive indegenization till 100% indegenization is achieved. This was an important aspect for the category of industries being investigated.

On Monday 20th November, Mr. Adirika, Senior Industrial Promotional Officer, Ministry of Commerce and Industry visited and informed that Dr.R.E.Aneke, Director of Planning, Ministry of Finance and Economic Planning was awaited to give further instructions; that they already had details of my duties and job description. All data

material and programme would follow the first meeting with Dr. Aneke and that Mr.Uzowulu would be in touch with me regularly. There was another informal meeting in the evening with Mr. Uzowulu on the various items for proposed auto spare parts industries, importance of Central Facilities, Quality Conformance and other inter related topics.

On Tuesday 21st November Mr.Uzowulu informed that the meeting with Dr. Aneke would be held next day, probably.

2.1.0 Later in the day I visited the Enugu office of Nigerian Bureau of Standards. In view of the fact the availability of Standards Organization and a good standards library, would be a vital infrastructural input to the proposed auto component industries of the region, this was a noteworthy and successful visit. Standards Organization of Nigeria with its head-quarters at Lagos was established in 1971 and is currently headed by Lt.Col.A.D.Etukudo. It is divided into 9 zones - 1) Lagos, 2) Enugu, 3) Port Hart Court, 4) Uyo, 5) Ibadan, 6) Kano, 7) Kaduna, 8) Jos, 9) Abuja. Functionally the Divisions are 1) Chemical Technology, 2) Codex (food) etc., 3) Electrical Engineering, 4) Mechanical Engineering, 5) Civil Engineering, 6) Textile Engineering, 7) Laboratory. They have a Quality Marking Scheme called NIS (Nigerian Industrial Standard) even-though it has not yet spread to the engineering industries. National level standardization work has commenced but is gathering momentum only gradually, which is natural for any standardization process. Zonal office at Enugu is headed by Mr. O.A.Otisi who was out of station during my

visit. They have a small chemical laboratory. Their library at Enugu office. even as it is today, has an impressive collection JIS, DIN, French, ASTM, IS etc and they can access any standards through Lagos quickly. The retrival at Enugu now is some what tedious, because regional industrial patterns and demands for reference standards are yet in the process of crystallization. Computerised data retrival is on agenda. I discussed the presence of this important facility at Enugu with Mr.Uzowulu and underlined the importance of NIS Quality Marking Scheme to the proposed auto spare parts industry where marketing will have to be done in the replacement market on the strength of quality. CIC could be a catalyst in this matter. I briefly discussed my own mission at the Standards Organization. The library should be reinforced with an extensive complement of DIN, JIS, BIS, etc., standards. Industries are to be encouraged to demonstrate compliance with any or any set of national standards as sufficient grounds to qualify to NIS Mark in the initial years of auto component industry in Anambra. This would help to get the required foot hold in the replacement market and promote sample submission to OE. Normally, the overseas assembly units of parent OEM have limited well defined roles in accepting samples and NIS mark would ease the process of OE acceptance of sample.

2.2.0 Discussed with Mr.Uzowulu some of the typical candidate auto component industries and general features of Nigerian raw material availability. Discussed the difficulties of opting for spark plugs. The pros and cons of automotive coil springs of all types, high tension fasteners, engine valves etc., which figured in discussion but have not figured in the

report dated 15th December 1989. Apart from the items which are not in the final lists, the included items were also discussed. The advantage of including components which are common to more than one category of vehicle (cars and tractors) and both petrol and diesel engines, were discussed in the context of the proposed set of auto component industries. On the question of technical man power, Mr.Uzowulu confirmed the prevalent opinion that the region has a high concentration of talented engineers; a good percentage with degrees from British, U.S. Universities. Many more from the region are spread throughout Nigeria in search of career opportunities. The qualified technical manpower base is strong in Anambra. Quite a number of them hold academical positions. The gap between qualified engineers in teaching positions and industry is very common. It exists in Anambra also. Given the incentives there are no reasons for talented young engineers not coming into industry, to build it up in Anambra.

Made a survey of petrol/diesel stations with attached garage and spares sales sections all of which are well organized as per international practice. Petrol sells at 0.6 Naira/Litre, HSD at 0.35-0.42 Naira per litre. Fast moving spares of West European makes are sold by the filling stations.

2.3.0 On Thursday 23rd November 1989, advised by M/s. Uzowulu and Mr. Nkwonta, I proceeded to meet Director General Mr. C.Udoye who was on a tour; where upon I called on Mr.Ongele, the Commissioner regarding delay in the formal meetings and planned programme. The Commissioner put me in touch with Director of Industries Mr. B.N.okafor. When I

requested for access to earlier reports on the matter, I was informed that Project Officer Mr. Mbacci would meet me next day and process the project work further. These were reported duly to GM, CIC Mr.Nkwonta who also conveyed his impression that the report to ADB must be with . Ministry of Commerce and Industry. He confirmed that Dr. Aneke had returned to Enugu.

2.4.0 Later visited the extensive garage facilities of UTC, Union Trading Co. Station Road, Enugu. This is an all Nigrian garage chain. Organization is modern, facilities are very good and mechanics are as skilled as any, anywhere in the world. From the point of view of spare parts, the implication of existance of such country-wide service facilities are most significant in two areas. No.1 such organised auto service stations shun spare parts of substandard quality. They block spurious spares but can catalyse quality conscious producers in the overlapping area between "Original Spares" and "Branded Spares". International experience shows, that the entrepreneurs from such large service facilities are the natural parents of spare parts manufacturing industry. UTC handles a large percentage of Peugeots. Another garage chain is Levantis which services Mercedes Benz. Subsequently I visited Emene Motors, Dealers of Peugeot and the Caterpillar Service Center on 30th November. Well organised auto service stations in Anambra are on firm footing and are organised on modern lines. The networking clearly shows the influence and conspicious presence of oil companies. To amplify it means that where oil companies have well organized well laid out filling stations with fast moving spares

and garage facilities, there is a built-in sense of consumer preference to high quality spares. This means that auto spare parts industry in Anambra has to be quality conscious from day one. This will be reflecting itself in the capital outlay, subsequently. Feasibility studies will have to assign weightages to capital and recurring expenditure required for production of auto spares of a well defined quality level. The chain, is as dwelt with here, is Nigerian Oil - fuel retailing practices - organised garage services - quality of spares - cost of producing high quality spares.

2.5.0 On Friday 24th November 1989, Mr. Mbacci deputed Mr.Ozonwu, Planning Officer to meet me. Mr.Mbacci informed that he was a member of the concerned committee and was interested in progressing further, which can but only follow after Finance Ministry clears. He fixed the meeting for Monday 27th November. All of these were duly reported at CIC to M/s. Uzowulu and Nkwonta.

The weekend 25th and 26th November was spent in study of technical and briefing material on hand and work of various options available for choosing candidate auto component industries for feasibility studies, approximate volumes and appropriate technologies.

There was a meeting with Dr.R.E.Aneke, Director of Planning at the Ministry of Finance and Economic Planning, on 27th November, Monday at the offices of Dr.Aneke where Mr.Uzowulu of C.I.C. Mr.Mbacci, Project Officer, Ministry of Commerce and Industry and Mrs. Agbo, Deputy Director, Ministry of Finance and Economic Planning were present,

besides me. Dr.Aneke spoke about certain administrative matters regarding ADB/UNIDO, all of which were outside perview of my own sphere of work at Enugu. I informed about the Preparatory Assistance Mission; Prefeasibility Study and Assessment Report that I would have to prepare. Since the Project Document came only thereafter, I requested for facilities for my work. I read out the job description and duties as given to me by UNIDO. Dr.Aneke instructed Mr. Mbacci to proceed to Lagos to get further details from the Government, in as much as both CIC and the Consultant to UNIDO, were not a part of the Government. I took down notes with permission of Dr.Aneke. Dr.Aneke spoke on the need to have a signed agreement between UNIDO and the Government in order to proceed in the matter. Both Mr.Uzowulu and myself separately reported the summary to General Manager, C I C, Mr.Nkwonta.

2.6.0 During the next three days Mr.Uzowulu was on leave but we held meetings on 29th in the hotel room with the data and material that I had carried with me plus the information generated locally.

The important points discussed concerned, "Project Document", "Pre-Project Work", "Preparatory Assistance Mission", "Assessment Report", "Methodology for generation of Data for a Project Document", roles of "Project Coordinator", "Project Personnel". Eventhough it was a prodoc for Facility Building, I used Prodoc No.DP/IND/83/017/4/01/37, to explain these aspects as well as the various ministries and agencies who clear a prodoc. The latter was intended to focus on the fact that a prodoc

has integrated into its very structure, an elaborate clearance structure. This meant that preproject work and preparatory assistance mission, assessment report etc., are inputs to a Prodoc because any prodoc would need to state the background and justify the basis for the project. Mr.Uzowulu was given to peruse the full complement of data assembled in my "Office-setup" in the hotel. He fully appreciated the ground covered already and the nature of my mission. This was on 29th November.

On 28th November I spoke to Sidfa and informed of Mr.Mbacci's mission to Lagos and was informed that I should further explain the scope of my mission, as a sequel to which the meeting with Mr.Uzowulu on 29th was arranged. It was arranged in my own make shift office in the hotel since the data, material, documentation and cross references were available there.

2.7.0 On 28th November I called on Dr.Hans Jurgen Ahlbrecht, Managing Director of Anamco, the Daimler Benz bus and commercial vehicle assembly plant at Enugu. Dr.Ahlbrecht was out of town. Met Mr.Godfrey Chike Onyia, Company Secretary Anamco and on his recommendation had a good meeting with Mr.Ronald Mueller, Production Engineering/Control Manager, Anamco. They do not assemble Mercedes Benz cars at Anamco. They assemble Trucks of more than 3 Tons capacity. Their installed capacity is for 7,500 vehicles per year even though current production is about 600 Diesel Trucks an year. They commenced production in 1980.

In 1985 they assembled 9 to 12 tonners. Since then, they have put out 32 seater buses and 50 seater 12/14 Ton big buses. They have on agenda active plans to induct turbocharged engines. Mr.Mueller informed that for the buses, excepting the "major aggregates" the rest was developed at Enugu. His opinion was that effect of import restrictions was one of delay. Regarding component development work at Enugu, he was satisfied. Caliber of draftsmen was satisfactory and engineers needed more exposure and training. Some had been trained at Stuttgart. Regarding production of local components, it is a question of price, volume. tooling costs of vendors. OE are definitely interested in local supplies. In case of Anamco, the money is locked up for 9 months from L/C to assembly, if ordered from Germany, where also there is a lead time produce on receipt of firm orders. Local supply means greater flexibility. Quality standards however have to conform to Damler Benz Standards. Anamco is willing to give the confidential specs. to bonafide vendors. They have a first class Training Center where they give a 3 year course in Automechanics, Auto Electricals, Fitting, Turning, Milling, Boring and Sheet Metal work. Skills are there to be moulded and trained. Volkswagon and Peugeot are assembling about 100 cars a day. The mood in diesel vehicle industry is quite optimistic. Dieselization appears to be on the verge of take off.

2.8.0 On 28th I later visited office of Engineer Dr.P.A.C.Amechi, Rector of the famous Institute of Management and Technology, Enugu and was directed to meet Dr.G.C.Ezimora, Deputy Rector of IMT, Enugu,

who immediately called in Engineer Mr. J.N.Uba, Associate Professor of Mechanical Engineering (Specialization Machine Design) and Mr.E.O.Annammah, Lecturer in Mechanical Engineering (Specialization in Production Technology). IMT has a Consultancy Center. Dr.Ezimora is the Chairman of the center and Mr.Uba is the Secretary of the Consultancy wing. Mr.Annammah is incharge of the Central Facility which is based on Industrial Center concept. I visited this also. New facilities are in final stages of being commissioned. The Consultancy Center is eager to take up industrial assignments. In order to catalyse the involve the staff members interest in industrial work, the Consultancy Center provides that 50% of profits go to concerned staff members. There are 29 Polytechnics in the country. Dr.Ezimora also spoke on current work and thinking at Government level on training on vocational education. Anambra State University of Technology, Enugu, currently are making use of IMT facilities. Their idea of 'Industrial Center Concept' aims to engage in industrial production activities in academical setting. Dr.Ezimora compared it with a teaching hospital. A half a ton foundry is under commissioning. In the workshop they make many spare parts; amongst them auto spares. There were Peaugeot piston castings awaiting machining; a drive shaft for Peaugeot 305 being finished on lathe by a college lecturer prior to heat treatment and grinding. Thus, there exist nuclei in Enugu, from where the auto spare parts industry can draw help for - a) Technical manpower, b) Central facilities at least at the commencing stages. While planning new class of auto spare parts industry it would be very useful and economical to draw from and draw on all available pool of indigenous resources. The IMT Consultancy Wing is

to-day capable of making a start for prototype development for proposed spare parts industries, given the opportunities and encouragement. It would be an useful idea for CIC to increase the level of interfacing with IMT. Mr.Uzowulu is aware of the potentialities.

On 29th November there was a meeting with Mr.Uzowulu on various aspects connected with Pro Docs, Pre-Project work etc., which has been reported earlier here.

2.9.0 Later in the day I visited the grass roots auto garages, mechanics shops and spare parts shops in Coal Camp. On many counts and general public opinion, these mechanics are famous for their skills in keeping vehicles on the go despite odds. Here also their first preference is for genuine and high quality spares. One opinion was that the indigenous fledgeling spurious auto spare parts industry gives them a 'Made in Taiwan' stamp. They are sold at cut rates.

2.10.0 On 30th November Thursday, I visited Peugeot agents M/s. Emene Motors and met Mr.N.N.Azikiwe their Executive Director who confirmed the bad slump in car sales during last two years. Regarding spares he said that apart from absence of price control, there was also the element of cornering. Enugu according to Mr.Azikiwe was amongst the best of sites for spare parts production because of a) Native skills and attitudes, b) Proximity to Port Hartcourt and the logistical advantages, apart from proximity to oil industry. Emene Motors is organized and

equipped on very modern lines. Later in the day I visited Caterpiller's Tractor & Equipment Division of UAC of Nigeria and met Area Parts Sales Manager Mr.D.Ogunmola. This was a sequel to an earlier meeting with Mr.R.A.Fox International Sales Manager, CAT, UK and Mr.R.Adenyi, Manager Offshore Funded Sales of Caterpillar. This visit was supplementary to visits to UTC, Emene Motors, Levantis. Caterpillers have well stocked spares and as per their world wide policy, there is no scope for substitutes. The Enugu depot spares are on microfiche and good service facilities exist. Their facilities in Lagos, is amongst one of their largest in the world and have facilities such as engine dynamometers to approve reconditioned engines. However, large numbers of Caterpiller off highway vehicles are in disuse due to some times trivial reasons and secondly lack of timely funds to buy spares. The implications from these visits is that the auto spare parts industry in Anambra has to place heavy emphasis on quality from day one.

2.11.0 On 1st December discussed with Mr.Uzowulu that it was very necessary that I visit some local spare parts industries in cooperation with CIC. It had been mentioned in office correspondence that local entrepreneurs were there. it is but natural that I should interact with them to be realistic when I make deductions regarding choice of parts, quantities etc., and this I have to do in collaboration with CIC. Mr.Uzowulu was of the opinion that I should visit the Onitsha Spare Parts market and the industries around Nnewi, on 5th November, with one of their younger engineer officers. There were continuous exchange

of ideas about availability of Nigerian raw materials for auto component industry with Mr.Uzowulu. From availability of tin to logistics of obtaining steel and alluminium scrap. The exchange of ideas encompassed also the choice of candidate industries. At this time, filters were still being considered.

During week end 2nd and 3rd December, I studied the CIIC report on filters and gave comments to Mr.Uzowulu. Since : a) Baldo report noted that there were some filter manufacturers in other parts of Nigeria, already, b) Only filter inserts were sold in the spares market, c) There was hardly a sizeable demand for diesel fuel filters, d) Filter paper - which is a very critical item - has to be imported, e) The item did not have backward and forward linkages, I expressed that, possibly we should look around for more viable products which will also go to promote linkages that will strengthen the industry and country.

2.11.1 Mr. Uzowulu gave the list of following industries to be visited by me on 5th December 1989.

1) Klombe 3, Umuezekoke Village
Umudim Nnewi, Owerri Road Nnewi
Godwin-Kris Auto Spare Parts Company
Hq. 62 Onitsha Road
Nnewi, Tel 640005

Products: Steering hose and pad, shock absorber suspension rubber
Hydraulic Break rubber, Engine setting
Exhaust Damper rubber

2) Cento Group of Companies
Nkwo-Akwu village site
Iyaba Umudim, Nnewi
P.O. Box 999 Nnewi

Products: Fan blade, wheel cover, front and battery rear light cover red (plastics)

3) Mabros Industries Nig. Ltd
at Duoma/Umunna Amakwa
P.O. box 128 Ozubulu

Products: Autobody and metal parts, exhaust system, cabinet file

4) John White Industries Limited
at Agu-Inyaba Village
Umudim, P.O. Box 453 Nnewi
fan belts, motorcycle tubes
Industrial v- belts

5) Resources Improvement Manufacturing Co Ltd
Akwu-Uru Industrial Estate, Nnewi
Life vegetable oil

18 litres tine
4 litres plastic

6) Uru Industries Ltd
122 Dwerri Road
Akwu Ura Industrial Estate
P.M.B. 6 Nnewi
Tel: 046-460594

Products: Cables for clutch, throttle, brake, speed gear, choke

7) Ibeto Group, Nnewi
Batteries.

On Monday 4th December, I had a discussion on Industrial Estates in Anambra and allied topics with Mr. J.B.Onuorah, one of the mechanical engineers at CIC. There are Industrial Estates in Nigeria, State Governments acquire land and develop the infrastructure like road, communication, power etc. Industries get land at highly concessional rates. To be able to qualify for place in Industrial Estates, Feasibility Studies are an essential precondition. Industrial Estates are for both

small and large industries. For example Anamco is located in Emene Industrial Estate. The industrial estates in Anambra are i) Emene, Enugu, ii) Oji, iii) Awka, iv) Onitsha, v) Ozubulu (Foundry and machine tool project in progress), vi) Abakiliki vii) Nnewi, viii) Nsuka. Some of these are under formation. Labour is abundant and cheap. Villagers have ancient metal working skills. CIC, apart from doing feasibility, studies, supervises every detail, right from recruitment of key personnel, supervision of installation and commissioning, no load runs, full load capacity runs and is represented on boards of directors to ensure quality conformance. CIC are involved in Niger Steel at Enugu which is due to be commissioned in 1991.

On 5th December Tuesday, I visited the spare parts markets at Nnewi and Onitsha. I also moved extensively in the industrial belt. Of the 7 industries suggested by CIC, No.4 was for industrial and car 'V' belts and motor cycle tubes. No.5 was not a auto parts factory. No.7 was for batteries. No.6, for various auto cables, did not allow me to enter, or even to meet the officers in charge. No.3 could not be located reached. However visits to Nos.1 and 2, namely Godwin Cnis and Cento were satisfying and representative of the activity in the area. Mr. Emma Okonkwo, a metallurgical engineer with quality control background from Agakuta, now with CIC, accompanied me. The general observations follow. Whereas the road to Onitsha is modern, the bypass to Nnewi is mediocre. The industries are located in villages where roads are bad. There is a dense population of motor cycles in villages. Large number of petrol

engined small construction equipment like dewatering pumps, vibrators etc.. and heavy earth moving equipment are conspicuously lying idle all over. All heavy commercial vehicles are diesel. Industries, even those built inside villages having poor roads, are constructed on modern lines, neat, well laid out and well maintained. They are promoted by entrepreneurs with spare parts market background. The input they need most is the technological orientation towards profitable industries which are a few steps ahead in the technological ladder. Industrial Estates do not have common facilities like tool room or plating shops nor supplementary feeder industries in the vicinity. They are more or less operating as stand alone units without linkages and hence their tendency to gravitate towards easier items. Nevertheless the motivation is high. Organization is good. Engineering support meagre. Godwin Chris started production in March 1989. Met Mr. Sunday Ugwu, a Chemical Engineer from IMT working as Production Manager. They use Nigerian Rubber, Nigerian Sulphur and Carbon black from NNPC. They import synthetic rubber. They have made prototype engine mounts for VW engine mounts and approached VW. They make various rubber bushes, seals etc. They are enlightened in their outlook. At Cento Group met Mr.Onwuka, the Administrative Manager. They make all types of HDP plastic injection moulded auto parts. HDP from NNPC is expected in near future. The bottle neck is in dies which they import from all parts of world including USA, Taiwan and Korea. They would welcome a die making facility in the area so that they can expand as market opportunities open up. There are a very good number of HDP parts in the modern cars now on Nigerian roads. Rear view mirror holder, wind screen

wiper assembly, handles for raising window glasses etc., etc. But these are precision moulded items and will require a regular supply of high precision dies, which under present day condition are produced using CAD/CAM techniques. When considering rubber items also the question of die shop will arise. Thus a modern die shop as a common facility would be valuable central facility for rubber and plastic based auto component industries which are already taking roots due to easier availability of raw materials.

On 6th November the summary of my visits were given to Mr. Uzowulu and Mr. Nkwonta. Preparation for Mr. Galamas visit were commenced.

2.12.0 On 7th December I visited the NNPC depot and met Mr.E.C.Kalu, the Depot Chief. Discussions were on the quality of fuels, percentage of off take of diesel to total fuel off-take, and present and future products from NNPCs petro chemical complex. Polypropelane, carbon black and similar raw materials which get into auto components are under production.

On the same day on 7th December, I visited the Projects Development Institute (Proda) of the Federal Ministry of Education Science and Technology at Independence Layout, Enugu. Engineer Mr. E.O. Kaine is the Director who was indisposed and at home. However, we discussed at length over the phone areas of mutual technological interest areas. It is very interesting that Proda, have with them,

Nigeria's first indigenous project for four wheeled passenger carrier. It is called the low cost vehicle and was commissioned in December 1987. It is designed for both rural and urban usages and is meant to come out in three versions; namely passenger, goods pick-up van and delivery van. Preliminary designs of first prototype were made by May 1988 and the first drivable vehicle was made in September 1989. It is almost hand made. The under carriages (suspension, steering and brakes) have over 60% local content and over 85% local inputs. Further developments are under way. The temporary specifications include an air cooled, 2 cylinder, four stroke engine, transmission with four forward and one reverse; Rack and Pinion steering box, Proda geometry, track rods, independent Macpherson strut damper, anti roll bar, heavy duty dead axle, rear coil springs. Director Mr. Kaine was very enthusiastic about the progress and conception of the project. All these visits, when put together, give a complete picture of Anambran automotive engineering skills in theory, practice, production, industry and trade. Visits to IMT and Proda, confirm the existance of indigenous talent and capabilities at Enugu and Anambra, in the field of automotive engineering and automotive component development capabilities.

2.13.0 With the background information gathered during the extensive field work, I sought an interview with Mr. B.N.Okafor, Director of Industries in the Ministry of Commerce and Industry to get official information on incentives that will be available for the envisaged auto spare parts industries of Anambra, on 12th December 1989. This was

required as a complimentary input, for short listing of the candidate industries for feasibility studies. One requirement is the technological climate and base which I had already covered; the second requirement is the policy inputs, in all such cases. Mr.Okafor requested for an additional copy of Unido Publication on feasibility studies which had been given to Mr.Uzowulu.

Mr. Okafor commenced by outlining that incentives to industry by Federal and State Government is by statute. The Federal Government gives - a) approval for incorporation of companies, b) approval for setting up of industries, c) approval for foreign exchange for buying off-shore, or overseas components. However, the Ministry of Commerce and Industry of Anambra can always make special and strong recommendations and present the case. Apart from permission to establishing industry, Federal Government for permission is required for repatriation of profits. The Ministry of Commerce and Industry gives this form. In cases where State Government finds it vital for interests of state and country, the Ministry will be willing to come forthwith with special assistance and, even seek recommendations from higher levels. The Ministry also corresponds with embassies. Maximum help is accorded by the State Ministry of Commerce and Industry, wherever Federal Controls prevail. From the side of State Government scarce land is given at very low rates. Since the Government wants to encourage industrialization in remote areas land there may be allotted on even more advantageous terms. Industrial layout areas have been acquired in all 29 local government areas.

Power is given by Rural Electrification Board. There is a credit fund scheme for small scale industries. The definition of limit of investment (excluding land) for Small Scale Industries has been increased from 150,000 Naira to 2 Million Naira. The State Ministry of Commerce and Industry, prepares free of charge, on request, project profiles for promoters. They have also Advisory Services for loan finance and Technical Advisory Services for Plant and Machinery. Incentives are same for all Nigeria. Promotional literature of Anambra State is mailed extensively and distributed in trade fairs. There is an active project for reactivation of Emene Steel Complex (Niger Steel) where it is possible to extend it to produce forging quality steel. Training is given great importance here and is regarded as a precondition to take over. There are provisions to set up central facilities in industrial layouts. Currently it is in the form of Advisory Services, but is due to expand.

On the question of Protection, Mr.B.N.Okafor opined that, in addition to federal incentives, the State Ministry of Commerce and Industry can a) recommend easier access to foreign exchange, b) recommend total or partial ban on competing industries. There is no State Government tax on industries. Only federal excise, Sales Tax exemption may be recommended on selective basis. It is also possible to recommend concessions in excise duty to Federal Government. Not all companies wishing to invest in auto spare parts approach the Ministry. Mr.Okafor confirmed the availability of asbestos, rubber and tin.

The position of refined tin was not very clear though. Steel scrap is available in plenty. Part import content is acceptable and under SAP it is not necessary to get permission, if it is not a banned item and if money is available and is required for manufacture. Spare parts industry qualifies itself for being termed as high priority, because it has many backward and forward linkages. Mr.Okafor informed that foreign collaboration receives high degree of encouragement.

2.14.0 Mr.E.Galama arrived on evening of 7th December. From 8th December onwards there were a series of meetings at CIC, with Director General Mr. Cyril Udoye, with Director of Planning Dr. Aneke and an investors meeting, where Mr.Galama spoke about the scope of present mission and proposed feasibility studies. My role was to give supplementary technical and engineering information in support of his observations and central objectives. Apart from participation in these meetings, my work consisted of discussion of all data and information collected by me and sources of information available to me with Mr. Galama and finalise the core of my main report to Mr.Galama for being incorporated and integrated into his report which was taking shape between 8th and 15th December.

Before the commencement of my field work in Enugu and surrounding areas, there was a list of possible spare parts to be studied for feasibility studies. As a result of intensive field work and interviews the conclusions reached were:-

a) That there existed objective conditions to impart higher level of broad banded mechanical engineering technology content and automotive engineering bias to the list of industries to be short listed taking into account - i) forward and backward linkages, ii) promotion of quality consciousness and industrial capabilities.

b) That it would be preferable to short list 10 industries at present because the investors preferences were not known as yet.

c) That the size of industries should be medium and conservative so that future will be one of growth and expansion rather than the anxieties of market demand.

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## 3.0.0 IDENTIFICATION OF SPARE PARTS TO BE CONSIDERED FOR FEASIBILITY STUDIES:

3.1.0 In the Job Description dated 11th August 1989 the following auto spare-parts were mentioned and included for future analysis, prior to identification of spare parts to be considered for feasibility studies - i) oil filters, ii) air filters, iii) bulbs, iv) spark plugs, v) bearings, vi) pistons, vii) liners, viii) electrical components, ix) hydraulic components, x) transmission components, etc.

Naturally, these were the first to be considered at the commencing stages of the field work, study, survey and information generation exercises outlined in the earlier chapter. These were also the items were taken up for the continuous exchange of ideas with Mr.Uzowulu. Mr.Uzowulu added also the contact breaker points.

Therefore it is proposed to examine this list first, before coming to the ten candidates proposed for inclusion in Mr. Galamas report dated 15th December 1989. Factors guiding the analysis are - i) those outlined in job description, ii) information generated during field work and survey at Enugu, iii) considerations already covered earlier in the report.

Amongst the factors that have had to be taken into account are the technology considerations, and the backward and forward linkages, which will permit the development of a new auto spare parts industry in the

region starting with the five model exercises and studies; so that seeds of self perpetuation are contained at the very initial stages. At this stage, simple stand alone mushroom industries can be left safely to the individual entrepreneurs. Very large stand alone industries can be deferred. The factor that needs analysis is that of appropriate technology. If there are objective conditions for achieving a certain level of profitable technological sophistication, it is but only the obvious course to leave the softer options to the less sophisticated entrepreneurship. Sophistication will lead to higher profitability and growth potential in the chosen sector; in this case the automotive component sector. This also means that heavier or more complicated sub-systems had to be counted out from the present study, for obvious reasons of being premature. Thus, the choices have gravitated towards profitable, medium scale, intermediate technology products with good engineering content, as a supplement to the c ntry's present phase of industrial development in mechanical engineering manufacturing industry. Another important consideration, apart from linkages, is the broad banding of plant, machinery facilities and product mix, so that any slackness in demand can be countered by rapid diversification, with relative case.

### 3.1.1 OIL FILTERS:

Oil filters for diesel engines and oil filters for petrol engines are different in terms of duty. Diesel engine oil filters are bigger in size and have to function for longer intervals and handle oil which is dirtier, thicker, hotter and more acidic. Petrol engine oil filters have ligher duty to perform. In the passenger car replacement market, generally it is

only the catridge that is changed regularly. For genuine filters, the paper and adhesives are imported. There are also reported to be already same oil filter manufacturers in Nigeria. Even if a new replacement oil filter industry were to be considered, it does not have backward or forward linkages and will not contribute to industrial growth. This can be left to be taken up by entrepreneurs own initiatives. Diesel engine population being less the diesel engine oil filters are considered, but are expected to be followed up by passenger car filter manufacturers. The filters as supplied to OE consist of filter body, cover and relief valve assemblies but are not replaced, unless they break.

3.1.2 **AIR FILTERS:**

They are mostly of paper type and made out of imported paper. The texture of paper has to be of controlled to prevent particles of more than 5 microns from entering the engines. Generally it is recommended periodically to dust the air filter catridges with compressed air clean the cartridge and refit it; unless the paper is burst or is ruptured; which is not generally noticed. In case of passenger cars this is not a fast moving spare. Air filters in case of heavy duty diesel vehicles, tractors and earthmoving equipment became increasingly complicated, expensive and have a regular replacement market.

3.1.3 Bulbs are a fast moving spare and the industry can be started in small scale with some imported machinery. This is an industry which does not have forward and backward linkages and can be left to the individual entrepreneurs.

3.1.4 **SPARK PLUGS** are the vital links in the ignition circuit that have a controlling effect on combustion and hence influence fuel economy and emmission. They are low cost, high tech items. A figure is attached to the Report to illustrate the complex construction of this ubiquitious component. The terminal stud is manufactured from steel and the center electrode from a special alloy. Terminal stud and center electrode are anchored, perfectly sealed, in the insulator with the steel plug shell together with an internal seal and a crimping ring and crimped and shrink under high pressure. Ground electrode is also of special alloy. Perfect seal is vital. The insulator derived from controlled grade of aluminium oxide with vitreous additives and is of very special grade. Ceramics that are commonly known are not of the grade required for spark plugs. In high performance car engines the ignition voltage is of the order of 20-30 KV. The electrical strength has to retained at high temperatures which are reached in service. The thermal conductivity of the insulator in the operational range of up temperature of $850^{o}/900^{o}C$ is important. Spark plugs are a hitech capital intensive, low-employment-potential, low-value-added, mass produced item with closely held know how, and having almost 100% import content, which has to continue for a long time. One estimate for plant and machinery only, was US$ 8 million per capacity of one million spark plugs an year. The sintering kiln for ceramics which can never be stopped alone is estimated to cost US $ 1.5 Million; Extrusion press for metal body around US $ 1 Million. Process requires nickle plating for housing, earthing electrode welding machine, glazing automat, fusing furnace, ceramic kiln, ball mill, spray driver, insulator forming press,

sintering kiln, hot curling for sealing and a few more highly specialised plant and technology are involved.

Because of these considerations, this item cannot be recommended for feasibility studies for the present. However, it is possible to explore the desirability of the industry in the context of a very large assured domestic and export markets at a later stage.

Though mentioned as a seperate product, it is proposed to deal with contact points in this context, partly because it is a part of the ignition circuit and partly because of special materials and technologies are considered. Exceptionally high mechanical and electrical demands are placed on the contact breaker. The contact points are usually made of tungsten and mass produced by high-investment, vacuum brazing. As a result of transfer of metal during contact, a crater develops on the breaker lever while the same accumulates on the other contact resulting in malfunction. Switching rates of 18,000 per minute are encountered. These require the special materials and technologies to be deployed. However, it is curious and paradoxical that cheap substitutes are made on small scale or in some cases, even cottage industry basis with substitute make shift materials. Such developments in the spurious spares sector can and do take place and pioneered by innovative mechanic artisans. From all these considerations plus the fact that it is a low cost item, it is not recommended for being considered as a candidate for the feasibility studies presently being envisaged.

3.1.5 **ELECTRICAL COMPONENTS:** These come under a very distinct industry, with a separate identity, called Auto Electricals. They consist of starter motors, dynamos or alternators, voltage regulator, wiper motors, head and tail lamps, blinkers, various connectors, switches, horn and other miscellaneous items. The relevant plant, machinery, test and prooving equipment are a class by themselves. These items are best taken up on the basis of an integrated approach towards auto electrics industry. Even then, establishment of a viable auto electric industry consisting of the many items may be profitable but do not promote linkages and industrial strengths. On the other hand some small scale industries based on individual initiative and enterprise will be born in an environment where more and more auto spare parts industries are born. Auto electricals come on their own strengths once the concept of a profitable auto spare parts industry takes roots. Auto electrical industry is expected to come as a result of spin offs from the programmed feasibility studies, an implicit aspect of which is to lead the way. On these considerations auto electricals are excluded from the present short listing exercises.

3.1.6 **TRANSMISSION COMPONENTS:** These are generally handled by OE themselves or by units under the umbrella of OE. Forging of gear blanks, gear cutting, hobbing, gear grinding, shaving, heat treatment, are a special technology. There are examples of specialised gear manufacturing units being established. They cater to needs of gears by other industries apart from automotive sector; and sell in the auto replacement market also. OE takes such meticulous care about transmission gears that, it is

difficult to establish which gears keep getting sold due to wear or breakage. Gear cutting industry is recommended for being considered for subsequent stages in development of auto components industry. However, the bushes and seals in the transmission system figure under bearings and rubber components later in the section on candidate industries.

3.1.7 There is an item called linings, after pistons in the job description. It is not clear if this refers to brake linings or cylinder liners. Brake linings are implicitely included under clutch facings and according to available information, including Baldo report, brake linings are already being manufactured. Since this item 'lining' figures after pistons, it is possible to consider it as meaning cylinder liners. Cylinder liners are more specific to diesel engines than petrol engines where it is customary to bore the cylinder block itself. With the present level of dieselization in Nigeria, cylinder liners do not have conspicuous scope. However, technologically the cylinder liner manufacture is close to piston ring manufacture. Piston Ring industry has been considered as a candidate for feasibility studies. Cylinder Liners have linkages with piston ring industry and will become prominent with progressive dieselization especially in the mass transportation sector. They will be candidates for diversification exercises of the piston ring industry as is evident from international examples.

3.1.8 - **HYDRAULIC COMPONENTS:** Under this the shock absorber has been taken up as a candidate industry for feasibility studies.

## 4.0.0 INDUSTRIES LISTED FOR FEASIBILITY STUDIES:

Feasibility studies are due for five selected auto spare parts industries in Anambra. One of the very important factors that comes up for consideration here is the preference of the investors in the choice of industry. This information is not available, as of now. In order to accommodate investor preference and interaction of criteria for indigenous raw material content, choice of collaborations etc., it is felt desirable to list out ten industries from out of which, five can be combed out at step - one of feasibility studies. This aspect has already come out in the report dated 15th December 1989 by Mr. Galama.

4.1.0 These industries are:-

1. Rubber items (oil seals, anti vibration mountings, various hoses and gaskets, wind screen wiper blades and miscellaneous small items).
2. Radiators and Radiator caps
3. Kingpin assembly/kingpin repair kit/sub-assemblies and ball joints etc., required to maintain king pin angle
4. Universal joints
5. Piston Rings
6. Bimetal Bearings and Bushes
7. Pistons for petrol engines
8. Shock absorbers
9. Leaf springs and spare leaves
10. Clutch plate and facings.

4.1.1 **RUBBER ITEMS:** Rubber is a versatile engineering raw material because of its mechanical, elastic, damping and sealing characteristics. The range of engineering products covered by natural rubber has been greatly enhanced by synthetic rubber eg. butyl rubber, chlorinated rubber, epichlorohydrin rubber, ethylene propelene rubber, fluoro silicones, nitrile, silicone rubber etc. Combinations of these have given more range to rubber components in automotive vehicles. There is a vast number of seals, bushes, rings, dust caps and gaskets in any vehicle. Weather strips for front and rear windscreens and door seals are amongst the larger components which have to pass severe sealing tests. Apart from control of their mechanical properties, control of profiles and dimensional stability, weathering properties came to play important role in turning the raw material to an automotive engineering component. Oil seals are critical and are located in a number of important places. Engine oil seals are more critical in the sense that they are exposed higher loads and temperatures. Oil seal failure results in seizures and expensive failures. Apart from engine mountings and radiator mountings there are a large number of bushes which also serve to damp out vibrations transverse or torsional. Rubber bumpers are another application. All rubber parts need regular replacements and, are fast moving spares. Under this item gaskets have been added to take care of not only rubber gaskets but also asbestos based composite gaskets such as cylinder head gaskets; not only on grounds of grouping but also because asbestos is an indigenous raw material to Nigeria. Except in case of oil seals, no foreign collaboration is necessary if processes are well controlled. The region is already strong in chemical technology.

The various machinery for mixing, curing, calendering and similar process and process control plant equipment which are more or less well established and conventional. It is proposed to highlight the importance of tool room and die making facilities which have to be located in the factory itself in order to be able to cope with the variety of products, sizes and shapes. Dies have to be made of special steels to take care of surface finish. Oil seal test rigs are important. The other products are best tested on vehicles for performance. Since this industry has already gaining ground there is a good scope to put this industry on sound footing and expanded base.

Only oil seals require foreign collaboration because the seal cross sections are complicated. SAE Standards on oil seals are a good guide. ASTM Standards are elaborate and have to be followed for testing and control of materials.

4.1.2 **RADIATOR AND RADIATOR CAPS:** A figure accompanys the report. The conventional radiator core is made of punched copper strip fins, brass tubes, brass top and bottom tanks. They are joined in tin lead solder baths. Percentage of tin is critical. Radiator cap is a steel sheet metal component with an accurate spring. Since thin gage copper and brass are used, this is a light and easy engineering industry. Once a radiator industry is established, the size of radiator is not important. The same industry can handle radiators of virtually all sizes covering diesel vehicles, earth moving equipment, stationary engines, compressors etc.

This means the market and potential for this industry is not circumscribed by the passenger car spares market only. Profitability and ease of establishing, make this an attractive product. The technology is optimum for beginners. Suppliers of plant and machinery for radiators also give process know how and the industry can be set up and operated indigenously without foreign collaboration. It has potential for multiplication, region wise.

### 4.1.3 KING PIN ASSEMBLY, KING PIN REPAIR KIT, SUB ASSEMBLIES AND BALL JOINTS THAT CONTROL KING PIN ANGLE.

An illustration of this item is a part of this report. The figure shows the king pin angle. King pin angle is the inclination of the steering axis (king pin) relative to the longitudinal plane and measured in the transverse plane of the vehicle and may vary from $2^{o}$ to $16^{o}$ depending on design meant to achieve the optimum angle. There is no one single design. Periodically either linkage mechanism is repaired by using repair kit or replaced. It shows up in vehicle handling characteristics when due for being attended to. It is a part of front suspension. It is a typical high precision light engineering auto component industry. One interesting thing about product is that once it is established there are good many linkages to other front suspension and steering gear linkages, joints and mechanisms, generally classed as "front end parts" which require periodic replacement. Ball joints, tie rod ends, stub axle, swivel joints etc. They require alloy steel small forgings, wearing surfaces

need hardening and grinding. Precision and quality control are vital. Tool design, Tool Room, Drawing office, Heat Treatment, Metrology and Metallurgical quality control and such other simple elementary but vital constituents of light mechanical engineering industry are very important not only from the point of quality as a parameter of profit generation, but also to give self confidence. Foreign collaboration is desirable. Since the designs change from vehicle to vehicle what is required is the reverse engineering capability rather than tie up with any famous overseas manufacturer. However, collaboration is required to learn reverse engineering skills which will be available from the newly industrialised nations and developing countries. Intensive practical training to the already qualified local engineers with experience and talent will be an important catalysing input.

One method of getting the specification is to get under the OE umbrella and liasoning with their vendor development functional area. The other method is to generate it by reverse engineering which implies developmental expenditure. The base in Nigeria for light mechanical engineering industry is not yet deep rooted though the phase cannot be short circuted in the process of industrialization and self reliance. Thus, this falls into a new category where careful planning is required and provisions to absorb some what lengthier jestation periods.

### 4.1.4 UNIVERSAL JOINTS:

An illustration is a part of the report showing the many variations that come under this definition. SAE J 901 b gives definitions of different types of universal joints starting with the familiar classic cardan universal joint with yoke, cross, needle bearings etc. Universal joints are used when the driving and the driven shafts are at different levels. The universal joints when welded to two ends of a tubular shaft becomes the propeller shaft such as the one seen between the gear box and differential of a vehicle. The illustration given shows use of universal joints for front wheel drive. These are meant to illustrate that there is no one single design or application. Essentially they consist of forged ends, hardened and precision ground cross, needle bearings, precision ground spline shafts etc. Wear and unbalance lead to failure of the connection between driving and driven shaft. The high precision component is subject to high levels of wear and tear and is a fast moving spare. As in case of radiators, once an industry is established for universal joints, there are applications in a number of areas. An extension to universal joint industry, is to be make entire propeller shafts. Failure of universal joint may need replacement of the propeller shaft itself. Thus, universal joint repair kit, universal joints, entire propeller shafts, constitute the spares in that order.

Some of the observations under kingpin and front suspension parts apply to universal joints also. This is also a typical high precision light mechanical engineering industry falling in the appropriate technology category. Collaborations from newly industrialised nations or developing

countries with good first hand experience would be required till reverse engineering techniques are mastered. Forgings are small in size which can be produced in-house or procured. Though small in size the part is subjected to fatigue and grain flow has to be controlled and ensured. Drawing Office, Tool Design, Tool Room, Heat Treatment, Metallurgical Quality Control, Metrology and similar small vital simple constituents of precision light mechanical engineering industry are required. Intensive practical training to the qualified local engineers is most desirable as well as provision for a lengthier gestation period. While considering collaborations and technology transfers, employment of foreign consultants and foreign technicians for reverse engineering may be considered as a good policy option.

### 4.1.5 PISTON RINGS:

Under this product only piston rings for petrol engines or, passenger car engines, are included Piston rings for diesel engines are more complicated and at this stage of dieselization in Nigeria there is not sufficient market for diesel engine piston rings to justuft the additional investments required. Piston rings come in four sizes; standard, first oversize, 2nd oversize and 3rd oversize. OE use the standard size. Ir. the replacement market the first replacement is of standard size, and 1st, 2nd and 3rd oversizes are used in first, second and third reboring stages. The top ring is chrome plated and the bottom ring is called the oil control ring having a special cross section meant to scrape back the oil from the bore surface, back to sump. The surface finish of the ring surface is a critical parameter

as well as the cross sectional dimension of the ring. A parameter known as ring tension is very critical. If it is harder than required, it leads to increased wear and if it is too soft it may cause engine performance problems like blow by and oil throw. Ring wear results in loss of compression and leads to starting problems. The material for is grey cast iron with fully pearlite matrix with random, A type graphite distribution, hardness 200/240 BHN and ultimate tensile strength of 25 Tsi. The top compression ring is chrome plated. The full material specifications are available in published standards e.g., DIN 70 909. The relative dimensions of different cross sections are also published e.g., DIN. The raw materials are pig iron, cast iron and steel scrap. For melting either electric induction furnaces are used; or the melting is first done in a cupola and the melt transferred to electric induction furnace for control of composition. Casting is either centrifugal casting or pot casting. In case of centrifugal casting the rings have to be parted. There is a further heat treatment process in a special furnace for process known as heat forming where gapped rings are fitted on a spacer mandrel. These are of importance because of control of ring gap. The machining is a precision machining operation with special mandrels and fixtures. Quality control requires carbon equivalent estimator unit, silicon estimator and chemical analysis plus sono test for tensile strength, micro hardness tester, chromium plating thickness measuring gage, surface finish measurement, piston ring tension checking fixture, metallurgical microscope for control of micro structure of the metal. Starting with petrol engine piston rings, the industry can proceed to diesel engine rings. It will be

relatively easy to extend to the cast iron cylinder liners because of common features of technologies concerned. Foreign collaboration will be most desirable. But it will not be necessary to go for collaboration with very famous manufacturers in industrially advanced countries who are geared up to very high levels of automated production technologies. Collaboration with piston ring manufacturers of newly industrialised nations, developing countries or small scale manufacturers in industrialised countries who will be catering for limited markets, are preferred. It is also important to give intense overseas practical training to already qualified local engineers in the specifies of the industry. Like in earlier cases, tool design, tool room, heat treatment have to form a part of the factory.

### 4.1.6 BI-METAL BEARINGS AND BUSHES:

Often there is some confusion in the nomenclature of bearings in the context of the automotive technology where the image of bearings is associated with ball, needle, roller, taper roller bearings which are extensively used in various parts of a vehicle. In this case the word bimetal bearings is used to signify the plain bearings - round and half bearings used in engines plus thrust washers and bushes. Bushes in a large number of cases are bronze bushes. They are normally produced by the same manufacturers because of profitability, common marketing groupings and common techniques of precision machining. Illustrations giving the general nomenclature and types of bearings are attached to the report. These bearings and bushes are high precision, high-value-added items which lend themselves to easy manufacture because the parts

are light weight items; the most skilful operations are in machine setting, tool selling and inspection gage setting. Machine operators and inspectors can be easily trained to do repetitive press tool operations and precision metal removal operations. The bearings associated with engines are main and big end half bearings, small end bush, camshaft bush, thrust washers and valve rocker bushes. On the vehicle there are bronze bushes for axle, steering gear box and miscellaneous bushes in suspension and braking systems.

There are three main type of bearing materials. Steel backed tin based babbit or white metal which is 90% tin as matrux with antimony and copper as alloying elements. There are non-engine applications for white metal bearings which offer diversification potentialities. White metal bearings have excellent embeddability conformability and resistance to seizure; micro white metal bearings having lesser white metal thickness have higher fatigue strength. Traditionally car engines have white metal bearings. The next category is the steel backed copper lead bearings with overlay. These are essential for diesel engines, but may go on car engines also. Same material is used for thrust washers and bushes. The third material is the more recent tin aluminium bearings. In case of white metal bearings the flattened steel strip is passed through the molten white metal bath, after which the white metal thickness is made uniform by knifing. The strips are blanked, pressed, holes and made and precision machined for oil holes, chamfers etc and fine bored whence the metal thickness is finally controlled and inspected. In case of sintered steel backed copper lead strips they under go very similar press shop and

machining operations but have an additional plating operation. The steel backed copper lead strips are a fairly complicated technology and in this case they have to be imported as contrast to white metal. In case tin-aluminium alloy once the alloying technique is mastered, the manufacture of the strip itself is done by roll bonding process where only the special roll bonding plant needs importation. Pressshop and precision machining, quality control techniques are similar to other plain bearings. In the present Nigerian context, copper lead bearings come at a fairly advanced stage; whereas white metal comes first. If tin aluminium alloying is matered, it is also possible to envisage the dropping of the copper lead variety completely because tin aluminium bearings are highly competitive with copper lead in price and performances. When bearing industry is set up, bushes come naturally because of ease of manufacture and profitability. They all need regular replacements and fast moving spares. This high precision industry was chosen because it is easy to manufacture and Nigeria has tin. Replacement bearings are offered as 1st and 2nd and 3rd undersizes whereas OE takes the standard sizes. Under size bearings are used when crankshaft journals and pins are reground. Like in earlier cases, Tool Room, Tool Design facilities form a part of the plant and machinery for the factory.

### 4.1.7 PISTONS FOR PETROL ENGINES:

There are two illustrations attached to the report showing the different parts of piston. The illustrations are common to both petrol and diesel engines. From the purview of the present study pistons

are diesel engines are excluded firstly, because there is no market at the present stage of dieselization in Nigeria, to warrant investment in manufacture of more complex diesel pistons which are more highly loaded and high tech developments are still taking place in the area. It is for these reasons that pistons for only petrol engines or passenger car engines are considered.

The basic raw material for piston is aluminium. Alluminium scrap can also be melted and refined. The material is aluminium silicon copper low expansion alloys having high thermal conductivity and good dimensional stability, corrosion and wear resistance in service. Raw material aluminium is heated and melted in electrically heated melting furnaces. Various select foundry chemicals are used for controlling metal composition, structure, cast ability and avoidance of foundry defects. Suppliers of these modern foundry chemicals are an important source of foundry know how. Composition has to be controlled at melting stage. Temperature control at melting and casting stage in the holding furnace are important. Casting is by gravity die casting followed by heat treatment consisting of solutionising and precepation hardening where very close temperature control of the order of $\pm 5^{o}C$ is required for improving strength and hardness. Material conforms to British LM 13 Lo Ex, or DIN A1 Si 12 Cu Ni Mg (DIN 1725) Micro structure has to be controlled by using metallurgical microscope. Machining process essentially is what is called as diamond cam turning to achieve dimensional parameters known as piston ovality and conicity. OE use standard pistons whereas

in replacement market it is the 1st, 2nd and 3rd oversizes that are sold. A simple good Tool Room, a Tool and Die Design facility and Drawing Office are an integral part of plant and machinery along with chemical metallurgical and metrological quality control facilities. Since the first stage does not involve more advanced diesel pistons it is not necessary to have collaboration with famous manufacturers of pistons of industrially advanced countries. However foreign collaboration is required and sources in newly industrialised countries, developing nations with corresponding experience, firms in South Europe serving smaller replacement market are some of the places to look for appropriate collaboration. As in other case, it is a very profitable input to give intensive overseas practical training to already qualified local engineers in production technology and reverse engineering.

### 4.1.8 SHOCK ABSORBERS:

There is an illustration attached to the report showing the construction of shock absorbers. Shock absorber is a hydraulic vibration damper cushioning between the vehicle and the road surface and integral to front and rear suspensions consisting of springs and other linkages all of which combined together give the vehicle its ride and safety characteristics. There are hydraulic shock absorbers and hydraulic plus gas filled shock absorbers. Apart from the protective tube, outer tube and inner tube (working cylinder) the piston and valves are small precision items that are typical of light intermediate technology industry.

Tubes are bought out items from tube mills whichmake welded tubes of various sizes, for applications such as cycles, transformers, etc. The load displacement characteristics of the shock absorbers as well as rebound have to be controlled. Cylindrs and valves are hardened and ground. Shock absorbers are also used on motor cycles. In an earlier part of the report the influence of motor cycle population on auto replacement market estimates have been indicated. Shock absorber dimensions are standardised to a large extent and the performance characteristics can be manipulated by modifications to valves. This is a light engineering industry. Good tool room facilities and inexpensive performance test rigs are essential. Know how can be had either overseas technical consultants with long experience in the area, reverse engineering and rigorous training to local well qualified mechanical engineers. No specific foreign collaboration is considered as essential. Baldo interim report has also just touched this item but has not gone into details.

### 4.1.9 LEAF SPRINGS AND SPARE LEAVES:

There is an illustration attached to this report giving examples of leaf spring applications including transverse mounting. Taper leaf springs are a new development for weight reduction. Steel is imported spring steel of high strength high fatigue life corresponding to DIN 17222 Ck 85 or equivalent. SAE J 510 C gives the specific actions that govern the characteristic features. The spring steel is flat rolled steel having two flat surfaces and two convex edges. There are fully elliptic, semi-elliptic or quarter elliptic springs. Multi leaf springs are

generally those having constant width with stepped leaves each of constant thickness except where leaf ends may be tapered in thickness. More recently the scope is extended to include assembly of stacked single leaves each of which is characterised by tapering either in width or in thickness. The manufacture of leaf springs involves hot working and rolling operations of spring steel strips akin to forging and critical heat treatment operations. The eye at each end has to hot formed. The control on chamber and proof load is imparted and effected during hot forming and heat treating and involves a combination of know how plus technology. Special purpose spring forming machines are used. Springs are finished by shot peening to increase fatigue life. The characteristic performance property of the leaf spring in its inch rate. The raw material is wholly imported but it is easy to master the technology of this fast moving spares item having high value added component. Collaboration in terms of consultancy with parties having requisite particularised know how, with or without engaging foreign specialists, can be explored along with collaboration with newly industrialised countries and developing nations. Particularised overseas practical training to local qualified engineers is essential in hot working, heat treatment, metallurgical control and furnace technologies.

### 4.1.10 CLUTCHES, CLUTCH PLATE AND CLUTCH FACINGS:

An illustration accompanies the report. The item has also been considered in Baldo report. Of the ten candidate spare parts considered, this item is a more complicated sub-assembly. In fact it is a small but vital subsystem of the power train. Asbestos used for clutch facing is

an indigenous raw material. Clutch plate steel is a special alloy steel with controlled flatness surface finish, wear resistance and other properties. Not all countries produce this grade of steel. Sweden and Austria are some of the specialised sources for clutch plate steels. Coil springs required for clutch assemblies will have to be imported till indigenous capability is established. Small forgings, precision machining, broaching, heat treatment, grinding are some of the processes involved in the manufacture. Foreign collaboration with a party from an fully industrialised country is required. Apart from being a good item for spares, this item represents slightly higher technology link in the chain of development leading to other constituents of automotive component section and represents a good example of forward linkage.

### 4.1.11 GENERAL REMARKS:

Earlier parts of the report have dealt with the exercises conducted to arrive at the list of 10 auto spares components from which 5 will be picked up for Feasibility Studies. Report dated 15th December 1989 by Mr. E.Galama alsocontains a summary of the considerations. Namely profitability, fast moving character, appropriate technology, import content, raw materials besides quality of fuel and road conditions which affect RTF.

While considering the individual products and industries in this chapter, there are some features which are common to most of them. They all require tool design capabilities to be imparted and have to be equipped with, a medium sized Tool Room. Tool Rooms are as much an integral part of

manufacturing technology in mechanical engineering industries as machine shop and foundry. Observations have been made in some earlier reports including the report by Mr.Gaiama of 15th December 1989 about the damping effect due to paucity of foundries and forge shops. When we think of automotive component sector, Tool Room, Tool Engineering, Heat Treatment, Metallographic analysis and interpretation are facilities and skills that are integral to the very concept of this new industry in addition to foundry and forge shops. It is also necessary to consider investment in quality control equipment and personnel on par with other investments. Some of these are not conspicuously prevalent in the current mechanical engineering industrial texture of Anambra. However, qualified local engineers are fully aware of importance and there are dormant skills as have been recounted under the field work done by the consultant and reported earlier. This is the rationale behind stress on further advanced intensive overseas practical training to the already well qualified engineers in particularised sectors of product technologies, production technologies, metallurgical and heat treatment technologies, tool engineering, methods engineering, quality control engineering etc. This is a part of project costs and has to be provided for under a specific head because of its significance in technology transfer, appropriate technology and reverse engineering. Another aspect is the options available, in so far as the above products are concerned, regarding foreign collaboration. Except in case of clutches, collaboration with firms from the industrialised nations is not considered as a precondition. One reason is that the technologies in the highly industrialised countries are so much more advanced with considerations such as automation, emmission control, environmental

considerations that these technologies are not very relavant to developing countries who have to take off from modest commencement. In fact this is the challenge of appropriate or intermediate technology. These concepts and techniques are not meant to either give rest to industrialisation or give scope for stagnation; but are meant as stepping stones or staging points as can be seen from example of a number of newly industrialised countries and developing countries. One option would be to explore collaborations from these sources. Alternatively, consultancy from specialists in the highly industrialised countries is also an option that needs to be explored. Whereas the specialist consultants, who may be catering to the modern needs of advanced countries, will, at the same time have the expertise in intermediate technologies through which they themselves would have passed through especially during early post second world war period. It is a part of job description to explore the technology availability, foreign technology, licenses etc. For the type of products being considered and the scale of production envisaged, the best course would be synthesize from all available options from reverse engineering with local and imported talent, to consultancy with experienced specialist consultants from industrialised nations, to collaboration with newly industrialised and/or developing countries could be examined along with collaboration with high competency, low profile medium scale firms in industrialised nations serving limited market areas. These require detailed exploration of all available optimum sources for technology transfer. This item requires extensive travelling by entrepreneurs and their team of engineers, which have to be accounted for specifically under project costs. Location of know how source, exercise of options and training of engineers

are a specific component of project implementation costs due to be incurred at the early stages of formation of an industry.

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## 5.0.0 PRELIMINARY ESTIMATES AND WEIGHTAGES:

## 5.1.0 POPULATION OF VEHICLES IN NIGERIA:

i) The source for further calculations is the Unido publication "Nigeria - Industrial Development Review Series" of 21 December 1988. Both tables and graphs.

ii) Figures for 1988 and 1989 are extrapolated.

iii) Road worthy life under Nigerian Road and traffic conditions is taken as 10 years for spare parts study.

iv) 1977 Nigerian Vehicle Production is taken as 100% Index to match the graph in Unido publication.

v) The peak production of 1982 which is 500% of 1977 production is taken as 100% production capacity.

vi) Vehicles means all vehicles i.e., cars plus other vehicles. Baldo report gives 60% as population of cars and 40% other vehicles.

vii) Vehicles older than 10 years are considered as being not in active use, for this study.

viii) Available statistical data on vehicle population and basic assumptions were jointly analysed and worked out at Enugu with Mr.Galama and they have also been incorporated in Mr. Galama's report of 15 December 1989.

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5.2.0 **TABLE - 1**

| No | | Year | Graph Index | Nigerian Production Nos. | Import Nos | % indigenous capacity installed |
|---|---|---|---|---|---|---|
| 1. | | 1975 | — | 13,728 | 57,321 | — |
| 2. | | 1976 | — | 31,003 | 42,221 | — |
| 3. | | 1977 | 100% | 40,223 | 50,727 | — |
| 4. | | 1978 | 125% | 50,279 | 24,523 | — |
| 5. | | 1979 | 145% | 58,323 | 6,501 | — |
| 6. | * | 1980 | 175% | 70,390 | (-) 7,912 | — |
| 7. | * | 1981 | 190% | 76,424 | 23,095 | — |
| 8. | * | 1982 | 500% | 201,115 | 18,817 | 100% |
| 9. | * | 1983 | 200% | 80,446 | Nil | 40% |
| 10. | * | 1984 | 60% | 24,134 | Nil | 12% |
| 11. | * | 1985 | 120% | 48,268 | Nil | 24% |
| 12. | * | 1986 | 60% | 24,134 | Nil | 12% |
| 13. | * | 1987 | 50% | 20,111 | Nil | 10% |
| 14. | * | 1988 | 40% | 16,080 | Nil | 8% |
| 15. | * | 1989 | 30% | 12,000 | Nil | 6% |
| | | | Total | 766,658 | (+) 215,293 | |

Total vehicles - 981,951 Nos - 15 year old

* See item 5.2.1

Taking the sum of vehicles in the above tables commencing from 1980 and ending in 1989, (marked *) we get the figure for number of vehicles as 607,102 Nos rounded to 600,000 as the population of vehicles less than 10 years old.

Vehicles produced in the two five year periods - (1979 to 1983) and (1980 to 1984) are respectively 527,119 and 486,643 which works out to an average of 506,881. This is rounded to 500,000 vehicles which will need maximum spares in 1992/93, when the industries now under feasibility study, stage would have entered full production and also generated secondary and teritiary activity in other auto spare parts industries which are expected to be given birth to by the pioneering set of five.

In the above tables capacity utilization in vehicle assembly sector has been seen to be dropping. There have been no specific incations about revival. In fact the CIC report of Nov 1988 on "Mass Transit Systems for Anambra" clearly states that reversal of trend is not expected in the present context.

5.2.1 From Table '1' and subsequently derivations (* in Table 1), we take vehicle population less than 10 years old as 600,000 vehicle population requiring maximum spares by 1992/93 as 500,000 and OE production as 10,000/year to estimate the demand for fast moving spares; from out of which a conservative figures for installed capacities is derived on a conservative basis for the Feasibility Studies. The strategy is to take off

with a medium compact quality conscious profitable industry, consolidate, grow and expand. It is oriented to quality, profit, technology and growth. It is not the intention to recommend large units based on total estimated demand because viability and safety of capital are important.

5.2.2 O.E. consideration is very important to build up credibility in the market. This aspect has been dealt with even at the beginning stages of the report. This is repeated again here because this involves development expenditure which has to be specifically provided for in the cost of project implementation. Like costs for travel to locate technology transfer sources, overseas training to indigenous engineers, consultancy, the development expenditure for including some tooling costs for developing samples for OE and other trials, have to be provided for specifically as a basic input to nourish the new born industry. This activity meant to satisfy OE quality standards is formally aimed at a notionally small OE market but is a very significant investment for market presence and growth in the replacement market. It will serve as an insurance and must not be overlooked.

5.2.3 Since it is not practicable to set up factories for 100% of the conservatively estimated demand, only 30% of this conservative demand is taken for estimating capacity of industries. As has been written earlier, most of the candidate industries have outlets in motor cycle diesel engine, tractor and other areas where there will be cushion over and above the conservative estimates to serve as a confidence booster to entrepreneurs.

## 5.2.4 RTF - REPLACEMENT TURNOVER FACTOR:

| | | | |
|---|---|---|---|
| Notes: | a) | Estimated vehicle population | 600,000 |
| | b) | Estimated OE production 1989 | 12,000/year |
| | c) | Vehicles considered for spares | 500,000 |
| | d) | Vehicles considered for OE | 10,000/year |
| | e) | No. of component per vehicle cited in the tables are average for 2/4/6 wheelers | |
| | f) | Abbreviated expressions are used to denote the industry which are fully explained under section 4.0.0. The short abbreviated descriptions given in tables should not be confused for single items. They cover the ranges described earlier. | |

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## TABLE 2

## R T F

| No. | Item | Nos/ Vehicle (avg) | Nos for 10 year life | Nos/ Year/ Veh. RTF A[1] | Nos/ Year/ Unit OE B[1] |
|---|---|---|---|---|---|
| 1. | Shock Absorber | 4 | 16 | 1.6 | 4 |
| 2. | Clutch Disc & Plate | 1 | 4 | 0.4 | 1 |
| 3. | Piston | 4 | 12 | 1.2 | 4 |
| 4. | Piston Rings | 16 | 64 | 6.4 | 16 |
| 5. | Leaf Springs & Leaves | 2 | 2 | 0.2 | 2 |
| 6. | Rubber items - | | | | |
| | a) Oilseals | 3 + | 9 + | 0.9 | 3 + |
| | b) AVMs (avg) | 3 + | 9 + | 0.3 | 3 + |
| | c) Hoses (avg) | 4 + | 24 + | 2.4 | 4 + |
| | d) Gaskets (avg) | 4 + | 16 + | 1.6 | 4 + |
| | e) Wiper blades | 2 | 2 | 0.2 | 1 |
| 7. | Radiator | 1 | 1 | 0.1 | 1 |
| 8. | King Pin Assy. etc | 2 | 6 | 0.6 | 2 |
| 9. | Universal joints | 2 | 6 | 0.6 | 2 |
| 10. | Bi Metal bearings (Pairs) | 9 | 27 | 2.7 | 9 |

## TABLE - 3

## PROJECTED DEMANDBASED ON RTF PLUS O.E.

| No. | Item | RTF | 500,000xRTF Annual Spares Demand | OE/ Veh. | OE Demand for 10,000 Vehicles |
|---|---|---|---|---|---|
| 1. | Shock absorber | 1.6 | 800,000 | 4 | 40,000 |
| 2. | Clutch facing plate | 0.4 | 200,000 | 1 | 10,000 |
| 3. | Pistons | 1.2 | 600,000 | 4 | 40,000 |
| 4. | Piston rings | 6.4 | 3,200,000 | 16 | 160,000 |
| 5. | Leaf springs and leaves | 0.2 | 100,000 | 2 | 20,000 |
| 6. | Rubber items - | | | | |
| | a) Oil seal | 0.9 | 450,000 | 3 | 30,000 |
| | b) AVMs | 0.9 | 450,000 | 3 | 30,000 |
| | c) Hoses | 2.4 | 1,200,000 | 4 | 40,000 |
| | d) Gaskets | 1.6 | 800,000 | 4 | 40,000 |
| | e) Wiper Blades | 0.4 | 200,000 | 1 | 10,000 |
| | Rubber sub-total | | 3,100,000 | | 150,000 |
| 7. | Radiator | 0.1 | 50,000 | 1 | 10,000 |
| 8. | King pin Assy etc | 0.6 | 300,000 | 2 | 20,000 |
| 9. | Universal joints | 0.6 | 300,000 | 2 | 20,000 |
| 10 | Bi metal Brgs (Pairs) | 2.7 | 1,350,000 | 9 | 90,000 |

## TABLE - 4

## TOTAL ANNUAL DEMAND AS PER TABLE - 3

| No. | Item | Spares/ year Nos. | OE/ year Nos. | Total Nos/ year-100% Demand |
|---|---|---|---|---|
| 1. | Shock Absorber | 800,000 | 40,000 | 840,000 |
| 2. | Clutch + Plates | 200,000 | 10,000 | 210,000 |
| 3. | Pistons | 600,000 | 40,000 | 640,000 |
| 4. | Piston Rings | 3,200,000 | 160,000 | 3,360,000 |
| 5. | Leaf springs etc | 100,000 | 20,000 | 120,000 |
| 6. | Rubber items | 3,100,000 | 150,000 | 325,0000 |
| 7. | Radiator | 50,000 | 10,000 | 60,000 |
| 8. | King Pin Assy. etc | 300,000 | 20,000 | 320,000 |
| 9. | Universal joints | 300,000 | 20,000 | 320,000 |
| 10. | Bi. Metal bearings pairs | 135,000 | 90,000 | 1,440,000 |

## TABLE - 5

## DAILY PRODUCTION FOR 100% DEMAND AS PER TABLE - 4

## BASED ON 300 WORKING DAYS PER YEAR

| No. | Item | 100% Annual Demand Nos | Daily production capacity for 100% demand |
|---|---|---|---|
| 1. | Shock Absorber | 840,000 | 2,800 |
| 2. | Clutch facing & plate | 210,000 | 700 |
| 3. | Piston | 640,000 | 2,200 |
| 4. | Piston Rings | 3,360,000 | 11,200 |
| 5. | Leaf spring | 120,000 | 400 |
| 6. | Rubber items | 3,250,000 | 10,850 |
| 7. | Radiator | 60,000 | 200 |
| 8. | King Pin | 320,000 | 1,100 (rounded) |
| 9. | Univ. joints | 320,000 | 1,100 (rounded) |
| 10. | Bi Metal Bearings | 1,440,000 | 4,800 |

## TABLE - 6

## ANNUAL INSTALLED CAPACITY FOR 30% OF DEMAND

## (300 WORKING DAYS)

| No. | Items | Daily Production | Annual Installed capacity |
|---|---|---|---|
| 1. | Shock Absorbers | 850 | 255,000 |
| 2. | Clutch facing and plates | 225 | 67,500 |
| 3. | Piston | 650 | 195,000 |
| 4. | Piston Ring | 3,400 | 1,020,000 |
| 5. | Leaf Springs | 120 | 36,000 |
| 6. | Rubber Items | 3,250 | 975,000 |
| 7. | Radiator | 60 | 18,000 |
| 8. | King Pin | 350 | 105,000 |
| 9. | Univ. Joints | 350 | 105,000 |
| 10. | Bi Metal Brgs | 1,500 | 450,000 |

These projections are based on meeting about 30% demand based on RTI which takes into account the excellent fuel quality, mixed road conditions and traffic patterns.

## 6.0.0 SOME PRELIMINARY PROJECTIONS AND NOTES ON THE LIKELY ORDER OF INVESTMENTS AND MANPOWER CONSIDERATIONS.

In the earlier chapter we started to establish conservative figure for a) vehicle population in Nigeria, b) vehicle population which is likely to be about 10 years old when these present industries become fully operational, c) vehicle population to be taken as basis for capacity projections based on RTF applicable to Nigerian conditions. From this, the recommendation for installed capacities for future feasibility studies have been deduced. The basis is a conservative approach; a compact, sound, strong, medium-sized-beginning as a launching paid for self sustained growth and diversification. Another reason for such emphasis is because these industries are meant to be born in Anambra State. It will take due time to establish viable all-Nigerian marketing network and effective market peneration during which time the production can be stepped to the conservatively arrived capacity and arrive at a take off stage when the other forward and backward linkages will be also maturing.

### 6.1.0 INVESTMENTS:

The investments indicated here exclude, land, buildings, infrastructure, power (HT & LT), communication, secretarial, promotional and administrative expenses. It excludes duties and taxes on imported and indigenous capital goods. It includes investment in plant, process equipment, machinery heat treatment shops, tool room, quality control

equipment including chemical, metallurgical and metrological equipment, design and drawing office facilities, test rigs, tool tryout, proto type development and basic prooving facilities, consultancy expenses in engineering and technology, cost of acquisition of technology viz., master lists, detailed drawings, specifications, national and international standards, data sheets for process control, stage and line inspection, quality control, raw material inspection, product evaluation data, technical documentation on earlier development and interpretation of acquired data. It includes exhaustive and intensive overseas technical training for all first and second level, line-function engineers for every functional technical area. It include training within the country for skilled labour and supervisory staff in production methods, tool room and quality control using facilities already available in the country plus, establishment of small in-house technical training schools to meet specific annual internal requirements of skilled manpower.

6.2.0 **MANPOWER** means personnel employed in direct production line activities including inspection and production related staff functions, such as, tool room, tool engineering, technical and drawing office, quality control, development and includes semiskilled shop floor personnel, skilled machine operators, machanists, tool and gauge makers, tool room mechanics, inspectors, draftsmen, technical supervisory staff, junior and senior engineers and line managers, metallurgists, chemists and chemical technologists; and excludes unskilled manual labour, clerical, administrative and managerial staff, in personnel, purchase, sales and accountancy functional areas.

6.3.0 **TABLE - 7**

**PROJECTED INVESTMENTS AND MANPOWER AS DEFINED UNDER 6.1.0 AND 6.2.0**

| No. | Item | Installed capacity per year | Investment. Million US $ as per 6.1.0 | Manpower as per 6.2.0 |
|---|---|---|---|---|
| 1. | Shock Absorber | 255,000 | 3 | 100 |
| 2. | Clutch facings and plates | 67,500 | 3 | 80 |
| 3. | Piston | 195,000 | 3 | 100 |
| 4. | Piston Rings | 1,020,000 | 2 | 100 |
| 5. | Leaf springs | 36,000 | 2 | 60 |
| 6. | Rubber items | 975,000 | 1 | 175 |
| 7. | Radiator | 18,000 | 0.5 | 50 |
| 8. | Kingpin Assy | 105,000 | 1 | 75 |
| 9. | Universal joints | 105,000 | 1 | 75 |
| 10. | Bi Metal Bearings | 450,000 | 5 | 200 |

The running thread of logic in defining investment and manpower is the technological muscle required for building up of credibility; and hence viability, which are required for not only for growth of industry concerned but also as models for the ones which will follow in the wake. The emphasis on sound technical foundation has for its perspectives not only the national market but also exports.

6.4.0 **RATINGS:** The next step is to assign ratings and priorities in terms of investment and raw material criteria. Raw material aspect has also been covered under 4.0.0.

## TABLE - 8

## RATING AS PER INVESTMENT/UNIT SKILLED MANPOWER

| No. | Item | Investment US $/Unit skilled man-power employed | Rating as per investment per man employed |
|---|---|---|---|
| 1. | Shock Absorber | 30,000 | VIII |
| 2. | Clutch Plate & Facing | 37,500 | X |
| 3. | Piston | 30,000 | VII |
| 4. | Piston Ring | 20,000 | V |
| 5. | Leaf spring | 33,333 | IX |
| 6. | Rubber Items | 5,714 | I |
| 7. | Radiator | 10,000 | II |
| 8. | Kingpin | 13,333 | III |
| 9. | Universal joints | 13,333 | IV |
| 10. | Bi Metal Bearings | 25,000 | VI |

## TABLE - 9

## RATING AS PER INDIGENOUS/IMPORTED RAW MATERIAL

| No. | Item | Principal input Material | Source | Rating |
|---|---|---|---|---|
| 1. | Shock Absorber | Steel & Tube | Import | VIII |
| 2. | Clutch etc | Steel & Asbestos | Import Steel asbestos indigenous | VII |
| 3. | Piston | Alluminium | Indigenous/ Import | III |
| 4. | Piston Rings | Pig Iron, CI & steel scrap | Indigenous | II |
| 5. | Leaf spring | Spring steel | Imported | X |
| 6. | Rubber items | Nat & Syn. Rubber | Indigenous/ Imported | I |
| 7. | Radiator | Copper & Brass | Imported | VI |
| 8. | Kingpin | Steel | Indigenous/ Imported | IV |
| 9. | Universal | Steel | Indigenous/ Imported | V |
| 10. | Bi Metal Bearings | Tin & Alluminium | Indigenous/ Imported | IX |

6.4.1 **RELISTING AS PER RATING OF PRIORITY**

**TABLE - 10**

RATING: $/MAN (AS DEFINED EARLIER)

| No. | Item | $/Man | Priority Rating |
|---|---|---|---|
| 1. | Rubber items | 5,714 | I |
| 2. | Radiator | 10,000 | II |
| 3. | Kingpin etc | 13,333 | III |
| 4. | Univ. joints etc | 13,333 | IV |
| 5. | Piston Ring | 20,000 | V |
| 6. | Bi Metal Bearings | 25,000 | VI |
| 7. | Piston | 30,000 | VII |
| 8. | Shock Absorber | 30,000 | VIII |
| 9. | Leaf springs | 33,333 | IX |
| 10. | Clutch and facing | 37,500 | X |

## 6.4.2 RELISTING AS PER RATING OF PRIORITY

**TABLE -11**

Rating as per source of Input Material

| No. | Item | Priority Rating |
|---|---|---|
| 1. | Rubber Items | I |
| 2. | Piston Rings | II |
| 3. | Piston | III |
| 4. | King pin etc | IV |
| 5. | Universal joints | V |
| 6. | Radiator | VI |
| 7. | Bi Metal Bearings | VII |
| 8. | Clutch facing and Discs | VIII |
| 9. | Shock Absorber | IX |
| 10. | Leaf springs | X |

## 7.0.0 CONSOLIDATION OF INFORMATION AND DATA GENERATED, AND SUBSEQUENT WORK:

7.1.0 An account has already been given of the intensive field work and information generation conducted prior to arrival of Mr. Galama on evening of 7th December. I accompanied Mr. Galama during his meetings with Director General Ministry of Commerce and Industry, Mr.Cyril O.Udoye and Dr.R.E.Aneke, Director of Planning in Anambran State Ministry of Finance and Economic Planning where Mr. Galama gave presentations on the proposed feasibility studies, the scope of present Preparatory Assistance Mission and the role of the Consultant. My participation was limited to technical clarifications that concerned my field of specialised work. On my own, I had an interview with Mr.B.N.Okafor, Director of Industries in Anambran State Ministry of Commerce and Industry, which has been reported earlier.

7.2.0 Consolidation of data and information as detailed under chapters 5.0 and 6.0 was done in consultation and collaboration with Mr.Galama of Unido between 8th and 14th December during which time both were in continuous touch with CIC.

Some of the important matters that were considered were - a) current choice of candidate industries vis-a-vis those that had figured in the job description and justifications thereof, b) proposal to give 10 numbers of semi-final candidate industries in preference to 5 numbers of final list for feasibility studies, in view of absence of data on investor

preferences, c) technology levels of proposed industries vis-a-vis the technology base available in Enugu and Anambra state and the concept of appropriate technology, d) size of industries and initial installed capacities, e) sources for technology transfer and collaboration; highly industrialised countries, newly industrialised countries, lately industrialised countries in EEC, and developing countries with requisite experience, f) importance of quality angle and importance of OE credibility.

It was also decided that the Consultant's detailed report should contain relavant illustrations to annotate the scope of the product and the industry because in some cases, the products are sub-assemblies, which though falling in one category, differ from vehicle design to design eg., king-pin assembly, suspension parts etc. This has been done and illustrations included except in case of rubber items and piston rings.

7.3.0 Thus the core of the Consultants technical data for Mr. Galama's report of 15th December 1989 were finalised and summary and conclusions were incorporated in the report by Mr. Galama.

7.3.1 This also served as preparation for the Investors' Meeting on 13th December 1989, where apart from the investors, the following officials were present.

| | | |
|---|---|---|
| 1. | Mr. B.N. Okafor | Director of Industries, Ministry of Commerce & Industry Anambra State .. Chairman |
| 2. | Mr. Vin O.C.Uzowulu | Deputy Controller, CIC |

| | | |
|---|---|---|
| 3. | Mrs. Agbo | Deputy Director, Ministry of Finance and Planning. |
| 4. | Dr. E.M.Gbanite | Director, Small Scale Industry Development Fund, Ministry of Commerce & Industry |
| 5. | Mr. Mbacci | Planning Officer, Ministry of Commerce & Industry. |
| 6. | Mr. E. Galama | UNIDO |
| 7. | Mr. S.V. Sastry | Consultant to UNIDO |

The presentation was given by Mr. Galama on the proposed feasibility studies and reflected the technical recommendations contained in Mr. Galama's report of 15th December 1989. I answered questions about level of technology, whether actual Nigerian road conditions, including rural ones, were taken into account along with the problems of rainy season. I also gave justification for level of technology content on the basis of field work done in Enugu - Onitsha - Nnewi areas.

7.3.2 On 14th December 1989 there was a meeting at CIC where all the above officials except Mr.Okafor were present. I accompanied Mr.Galama where there was a presentation by Mr.Galama on proposed Feasibility Studies and methodology. It also dealt with terms of references for future work. I was present. This also helped me to arrive at the format for the present report.

7.3.3 As observed at the opening stages, this report covers all the aspects outlined in the job description and duties. In view of discussions with Mr. Galama, the scope of future work which will be undertaken,

discussions with CIC, field work and, the nature and content of decisions and recommendations deduced and arrived at, the present style and format of presentation of the report has been preferred by the Consultant.

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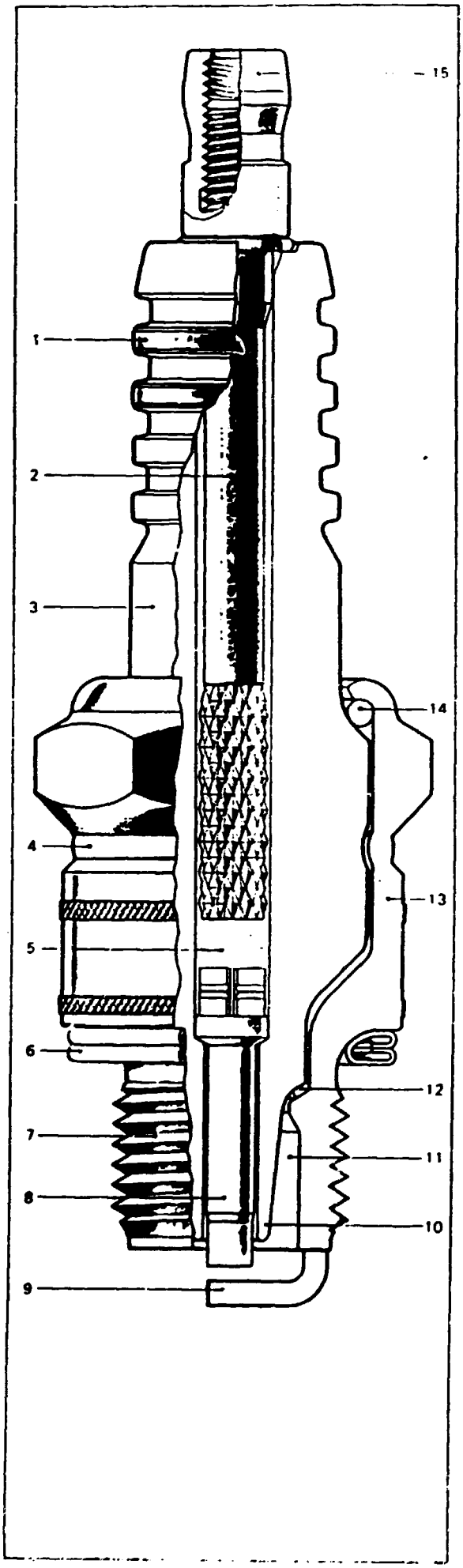
## 8.0.0 LIST OF ILLUSTRATIONS

The terminal stud is manufactured from steel and the center electrode from a special alloy. Terminal stud and center electrode are anchored, perfectly sealed, in the insulator with special conductive material. The insulator is inserted into the steel plug shell together with an internal seal and a crimping ring and crimped and shrunk under high pressure by a special process. The ground electrode is also manufactured from a special alloy and is welded to the plug shell.

This manufacturing process results in a spark plug which maintains a perfect seal in service and which can withstand the stresses of installation and removal.




Parts of the spark plug
1 Leakage-current barrier
2 Terminal stud
3 Pyranit insulator
4 Swaged and heat-shrunk fitting zone
5 Special conductive seal
6 Captive gasket
7 Precision thread with guide
8 Non-eroding special CR electrode (center electrode)
9 Non-eroding ground electrode
10 Insulator nose
11 Scavenging area
12 Internal seal
13 Spark-plug shell
14 Crimping ring
15 SAE terminal nut (by choice)

SPARK PLUG
FIG 1
REF: 3.1.4

# radiator

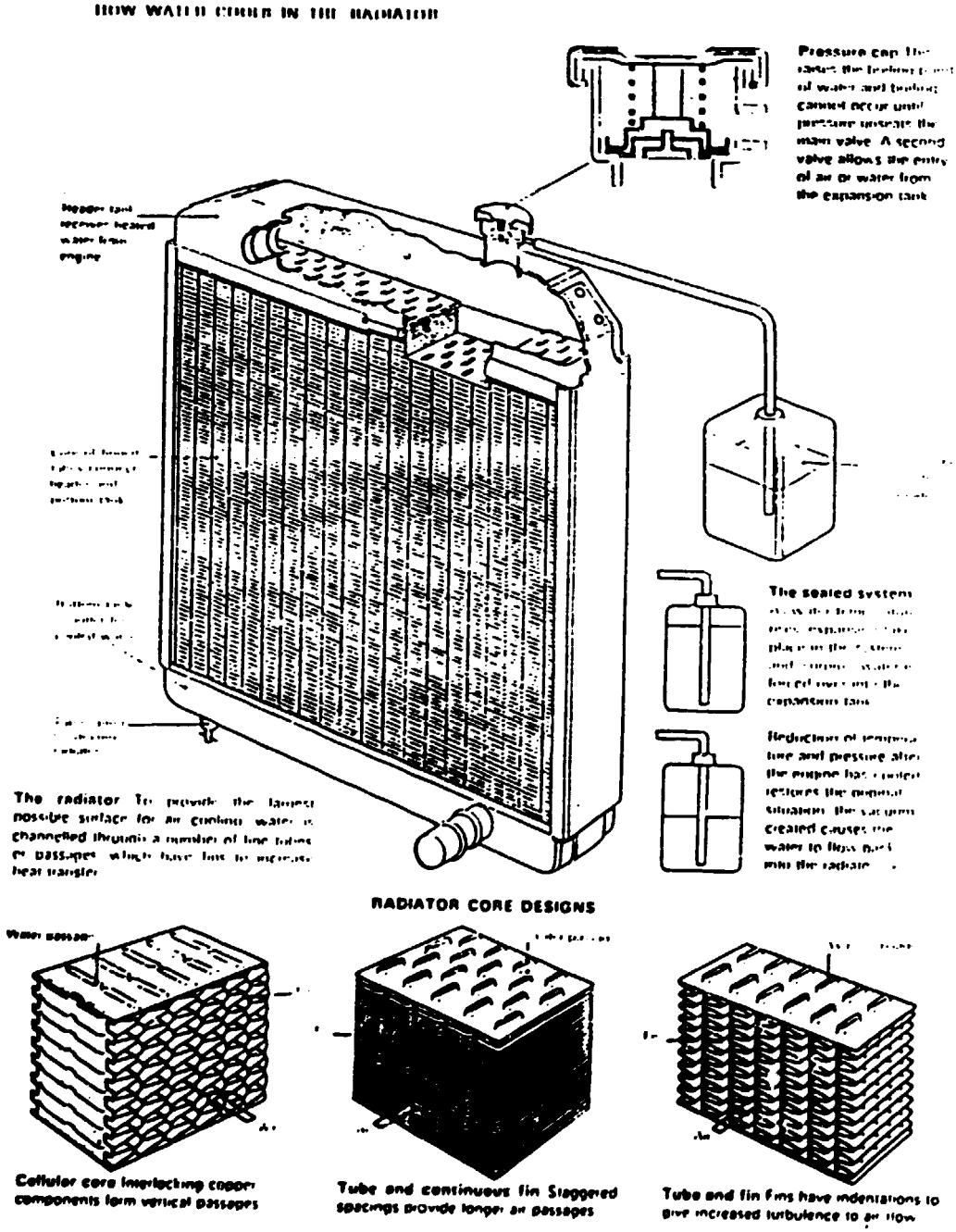
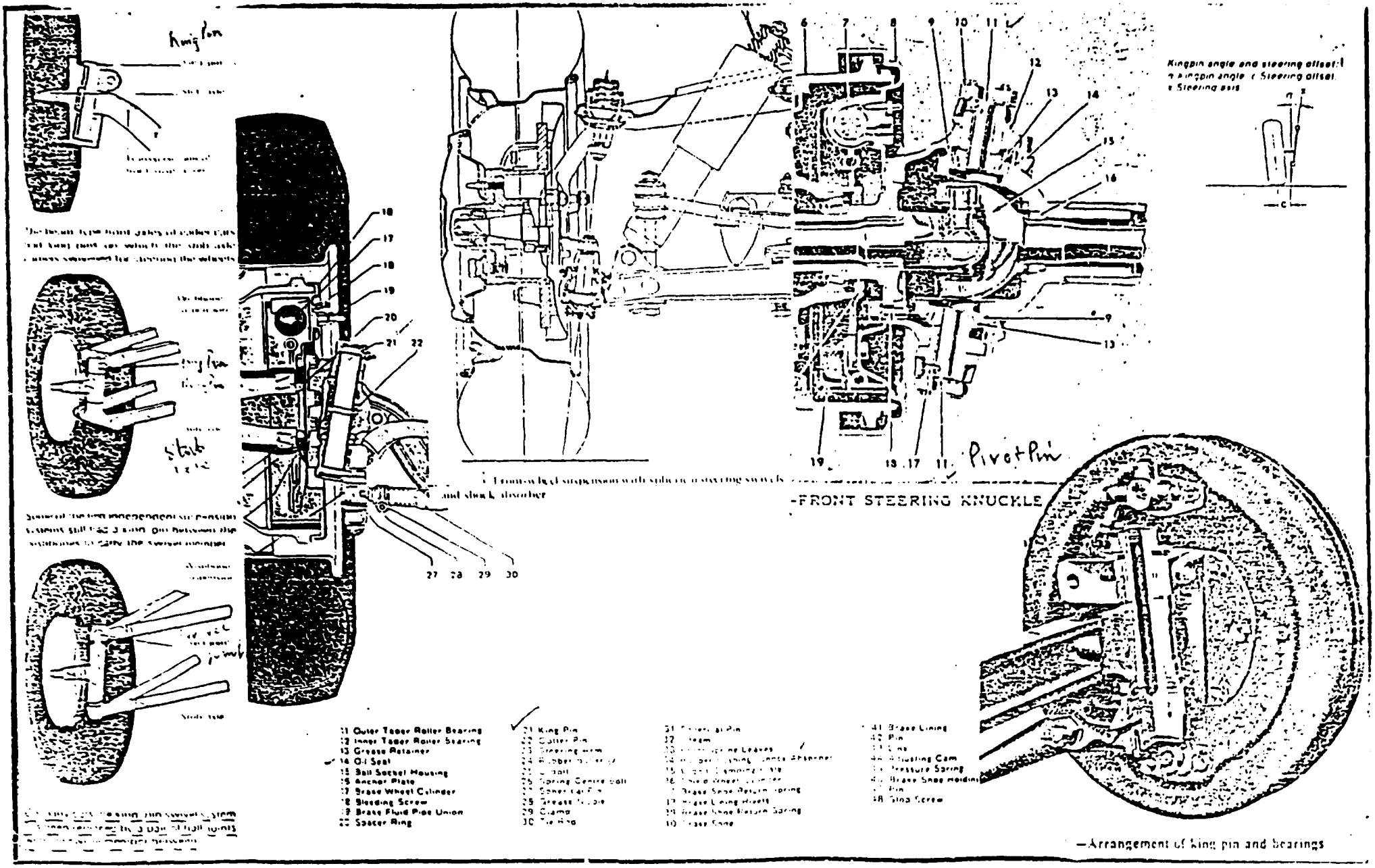
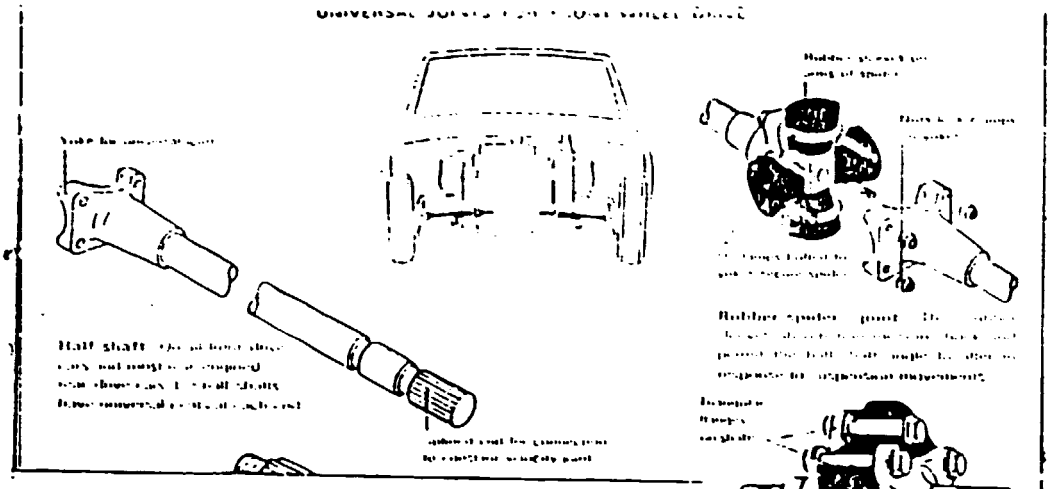
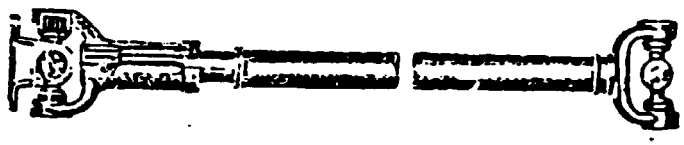


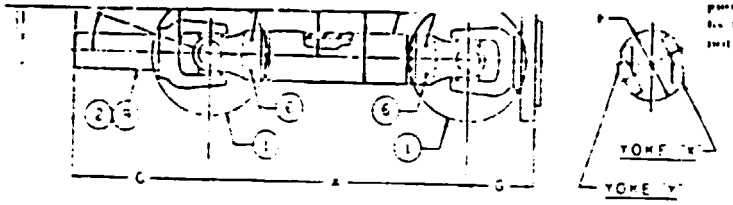

**FIG 2**
**REF: 4.1.2**



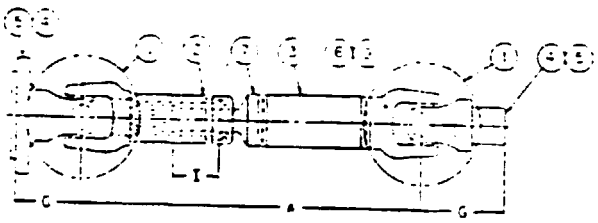

KING PIN ANGLE ASSEMBLIES
FIG 3. REF: 4.1.3



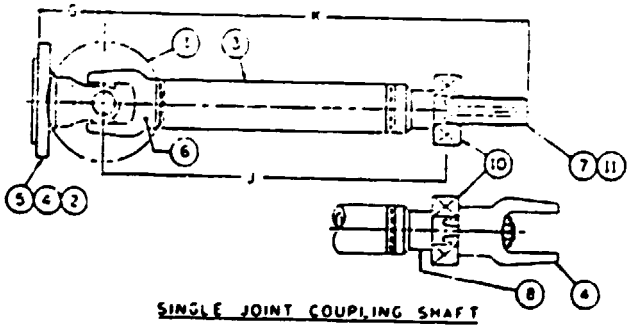




TWO JOINT OUTBOARD SLIP DRIVESHAFT



TWO JOINT INBOARD SLIP DRIVESHAFT



SINGLE JOINT COUPLING SHAFT

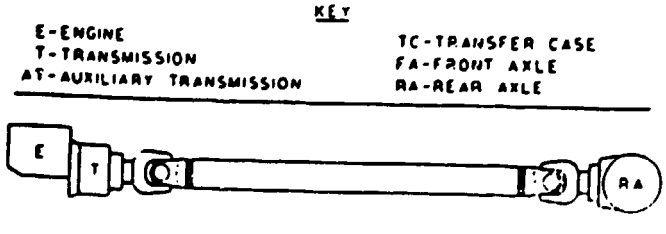
1 UNIVERSAL JOINT
2 SLIP YOKE (INTERNAL SPLINES)
3 TUBE
4 END YOKE
5 FLANGE YOKE
6 TUBE OR WELD YOKE
7 SLIP SHAFT (EXTERNAL SPLINES)
8 NON-SLIP SHAFT (EXTERNAL SPLINES)
9 SLIP YOKE (EXTERNAL SPLINES)
10 SHAFT SUPPORT
11 SLIP SHAFT (INTERNAL SPLINES)

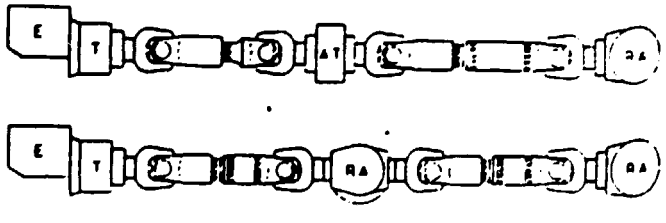
A FIXED OR COMPRESSED DRIVESHAFT LENGTH JOINT CENTER TO JOINT CENTER
B TUBE DIAMETER
C WALL THICKNESS
D JOINT ANGLE
E PHASE ANGLE
F SWING DIAMETER
G OVER-ALL LENGTH OF COMPONENT
H SPLINED LENGTH OF COMPONENT
I AVAILABLE SPLINE SLIP
J LENGTH FROM JOINT CENTER TO CENTERLINE OF BEARING
K LENGTH FROM JOINT CENTER TO SPLINED SHAFT END

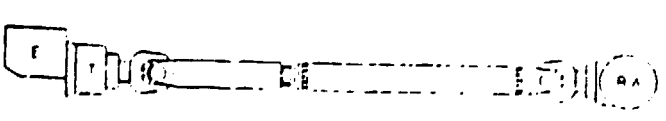
-TYPICAL DRIVESHAFT CONSTRUCTIONS

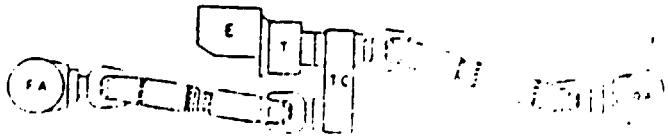
KEY

E-ENGINE
T-TRANSMISSION
AT-AUXILIARY TRANSMISSION
TC-TRANSFER CASE
FA-FRONT AXLE
RA-REAR AXLE





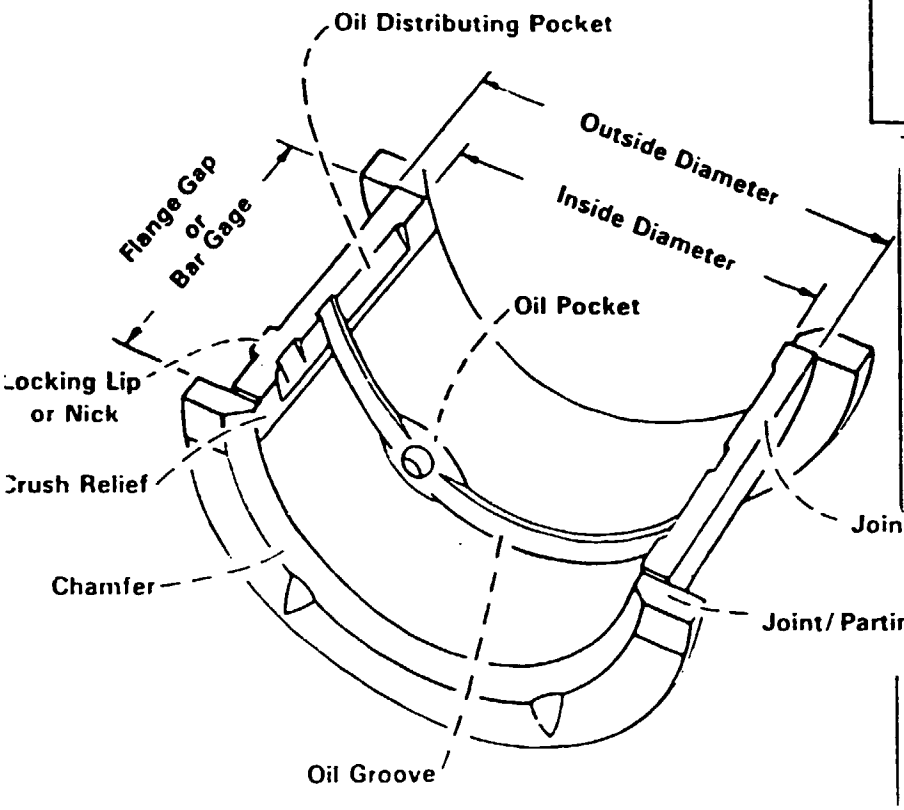


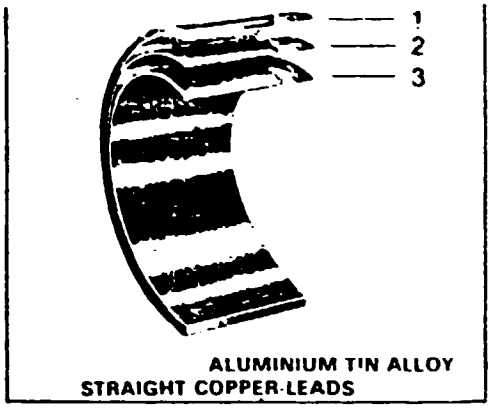


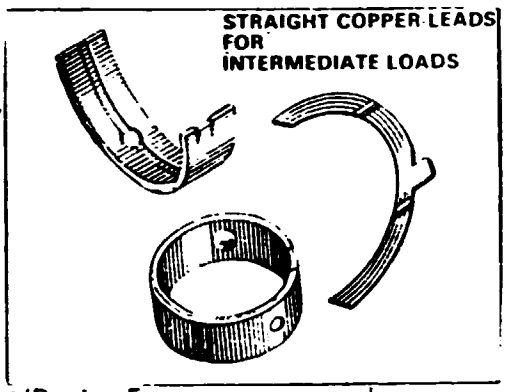
-TYPICAL TWO JOINT DRIVESHAFT ARRANGEMENTS

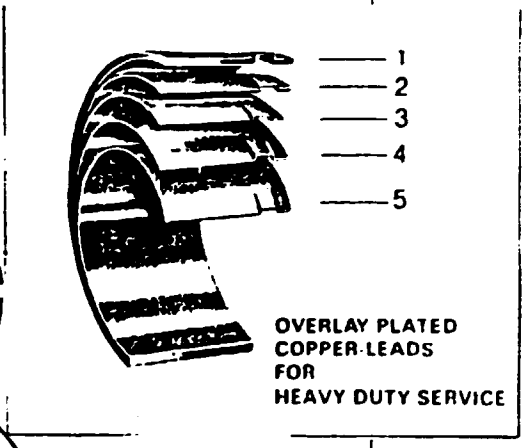
FIG 4
REF: 4.1.4

## BEARING NOMENCLATURE



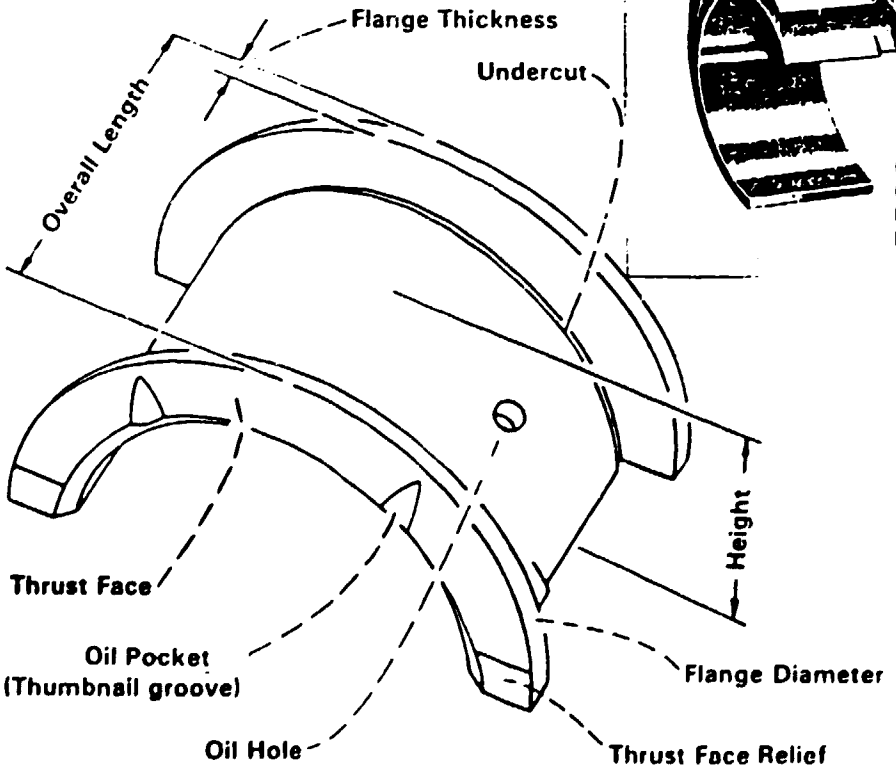




FIG 5
REF: 4.1.6

# Diese Zeichen bürgen Kennzeichnung



Auf dem Kolbenboden sind eingeschlagen:

1. Firmen- und Gütezeichen.

2. Maß des Kolbendurchmessers in mm, gemessen an der Stelle des größten Schaftdurchmessers (am unteren Schaftende, senkrecht zur Bolzenachse).
   Bei Kleinkolben ist meist nur die Maßgruppe und der Nenn-Ø gestempelt.
   Weitere Ø-Angaben und Einbauspiel sind auf der Verpackung angegeben.

3. Bei Kolben für Motoren mit Zylinderabmessungen in Zollmaßen zusätzlich zum größten Kolbendurchmesser noch die Hinweise »Std.« oder für die Übermaße z.B. ».020«.

4. Das Einbauspiel in mm gleichbedeutend mit der Durchmesserdifferenz von Zylinderbohrung und Kolbenschaft bei einer Temperatur von 20°C.

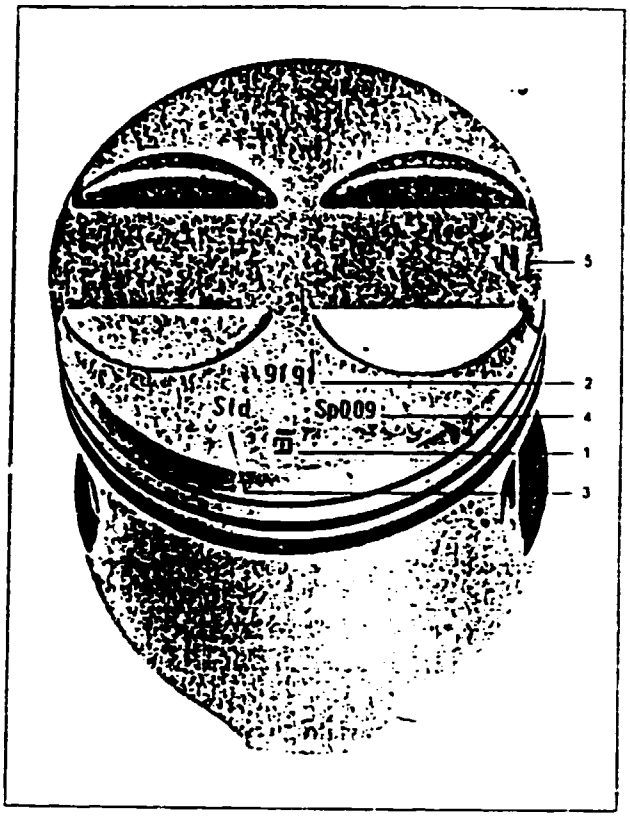
5. Die Einbaurichtung in Form eines Kurbelwellen-Schwungrad-Symbols, oder eines Pfeils für die Richtung zur Steuerseite des Motors. Auch die Bezeichnung »vorn«, »Front« oder »Abluft« oder eine eingegossene Kerbe geben die Einbaurichtung an, die nicht nur wegen einer unsymmetrischen Bodenform, sondern z.B. auch wegen der aus Geräuschgründen desachsierten Kolbenbolzenbohrung einzuhalten ist.

6. Zusätzliche Zeichen falls erforderlich, wie A = Auslaß, E = Einlaß, 1 = Zylinder 1, Z 2/3 = Zylinder 2 und 3.

**Die Original Ersatzkolben werden komplett und einbaufertig geliefert. Sie sind für jeden Motor als Satz verpackt, ausgenommen große Kolben und größere Assemblies, die in Einzel- oder Zweierpackungen geliefert werden.**

**Die Original Ersatzkolben werden wie die Serienkolben nach Qualitätsvorschriften hergestellt.**

**Außer in Standardabmessungen werden die Kolben auch in Übergrößen gefertigt, entsprechend den Übermaßstufen der Motorenhersteller. Ausgenommen davon sind lediglich solche Kolben, bei denen konstruktionsbedingt nur ein Standardmaß möglich ist.**




1 Firmen- und Gütezeichen

2 Kolbendurchmesser in mm

3 Standard- oder Übermaß in Zoll

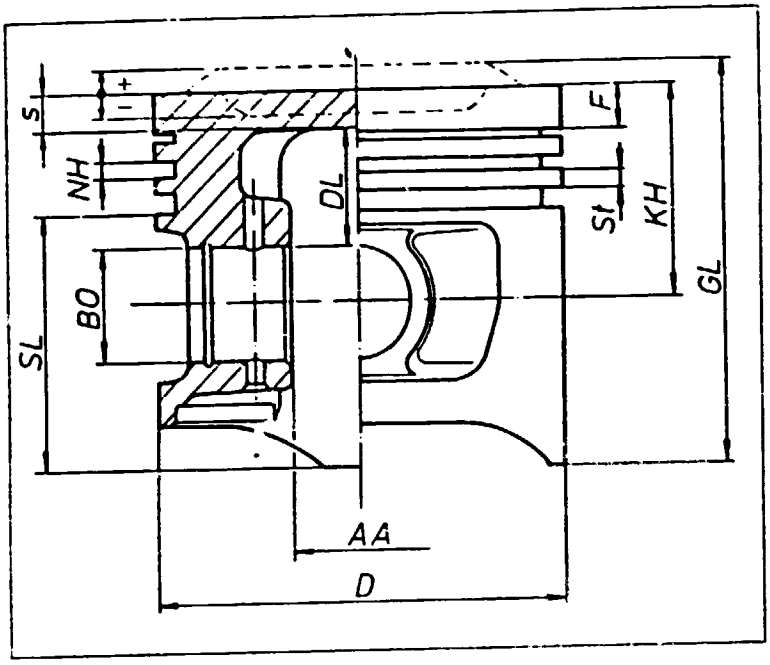
4 Einbauspiel in mm

5 Einbaurichtung

PISTON
FIG 6
REF: 4.1.6

# Hauptabmessungen des Kolbens






D – Durchmesser

KH – Kompressionshöhe
+ Überhöhung
– Vertiefung

GL – Ganze Länge

AA – Augenabstand

F – Feuersteghöhe

s – Bodendicke

St – Ringsteghöhe

SL – Schaftlänge

BO – Bolzenloch ø

DL – Dehnlänge

NH – Nutenhöhe

PISTON
FIG 7
REF: 4.1.7

# Zeichenerklärungen

**1. Kolbenausführungsarten**

A – Autothermik®-Kolben (frühere Bezeichnung)

V – Autothermik®- und Autothermatik®-Kolben

D – Duotherm®-Kolben

L – Vollschaftkolben

P – Kolben gepreßt

R – Ringstreifenkolben

G – Gußeisenkolben

RT – Ringträgerkolben

D-RT – Doppelringträger

RT-KK – Ringträgerkolben mit Kühlkanal, z.B. Salzkernkolben

RT-ESG – Ringträgerkolben mit Kühlkanal, elektronenstrahlgeschweißt

Armal – mit Muldenrandschutz und Ringträger

HA – hartmodifizierter Kolbenboden

**2. Kolbenbolzensicherungen**

SS – Seegersicherungen

Sp – Drahtsprengringe

**3. Zylinderbuchsen/Rippenzylinder**

WN – Nasse Buchse

WR – Rippenzylinder

WT – Trockene Buchse

WV – Vorbearbeitete Buchse

**4. Dichtungen**

G – Gummi (Perbunan, NBR)

K – Kupfer

P – Papier

Pa – Pagadur

PL – Plastik

Si – Silicon (VMQ)

Vi – Viton (FKM)

We – Weicheisen

**5. Zusatzzeichen**

1) Sonder-Ringwerkstoff

2) Stahlring

*) Liefermöglichkeit anfragen

## Shock Absorbers

The purpose of the shock absorber is to rapidly damp the oscillations of the vehicle body (driving comfort) reduce the dynamic wheel load fluctuations and prevent the wheels from lifting off of the road surface (driving safety)

Hydraulic telescopic shock absorbers of single or twin-tube design are used The shock absorber itself consists of a hydraulic cylinder in which a piston moves as flow resistance is overcome The pressure on the fluid (30 70 bar) suppresses foaming at high piston speeds

**Single-Tube Shock Absorbers**
The volume is equalized by means of a separating piston which is subjected to gas pressure.

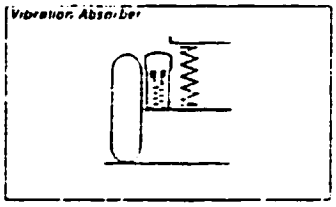
**Twin-Tube Shock Absorbers**
The volume of fluid displaced by the piston rod flows through the bottom valve

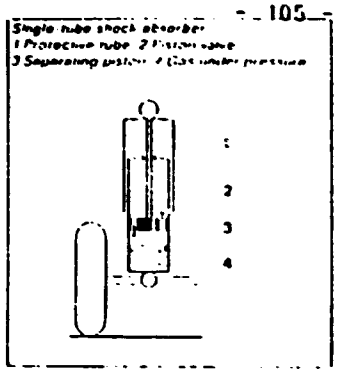
## Vibration Absorbers

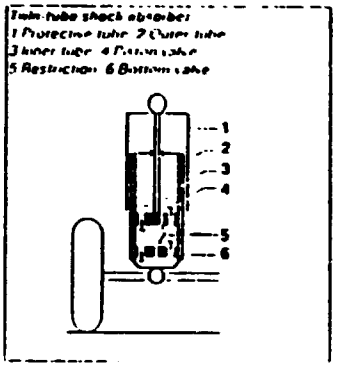
The damped spring-mass system mounted on the axle can improve driving safety, in some cases without having any effect on the vehicle body

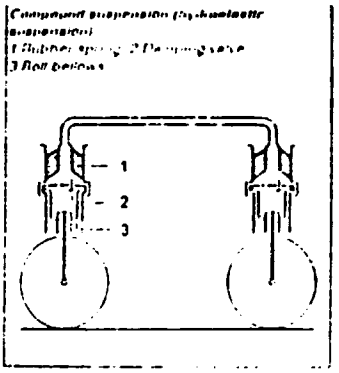
## Compound Suspension

Pitching movements can be reduced by mechanically or hydraulically connecting the front suspension elements with those at the rear of the vehicle

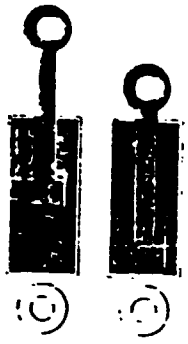


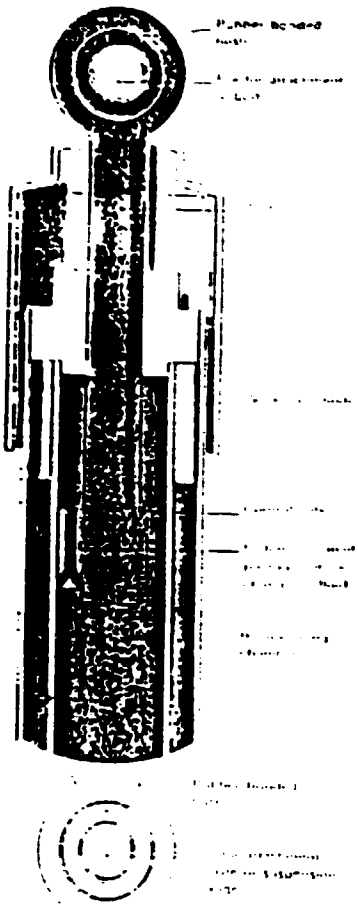




## TELESCOPIC DAMPER



**Damping** The



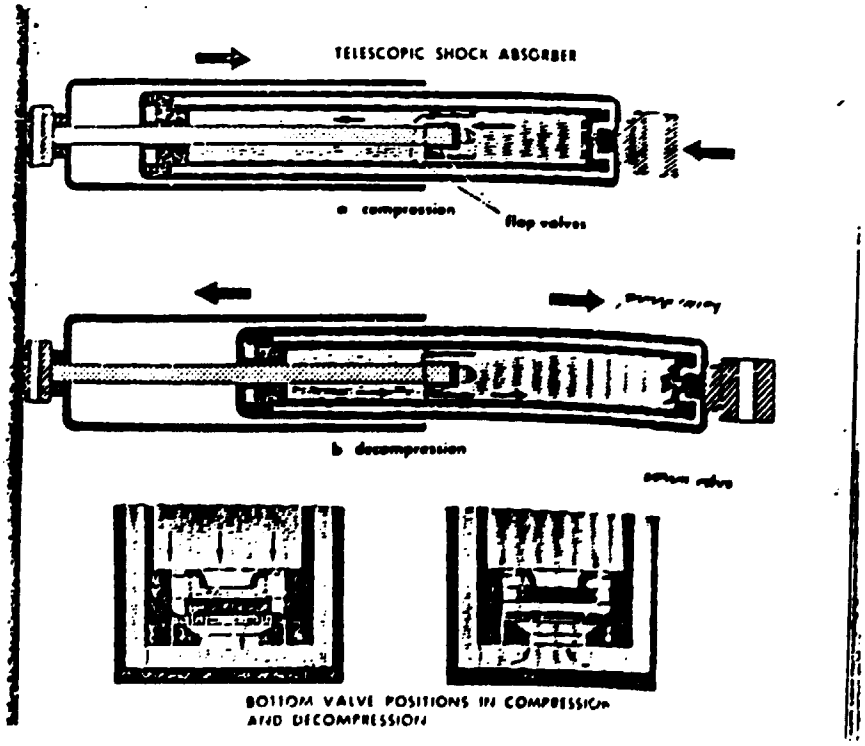
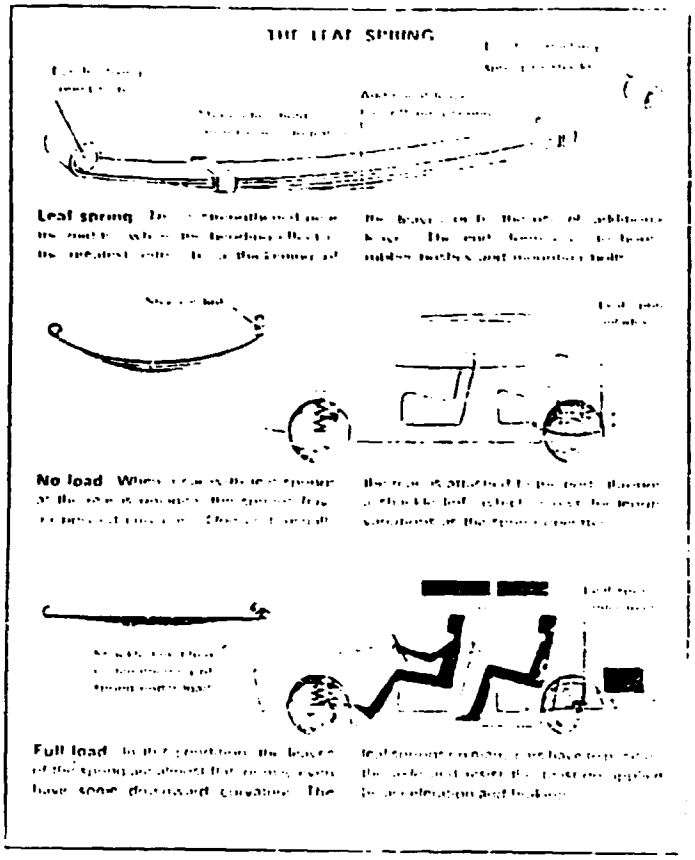



FIG 8
REF 4.1.8


THE LEAF SPRING

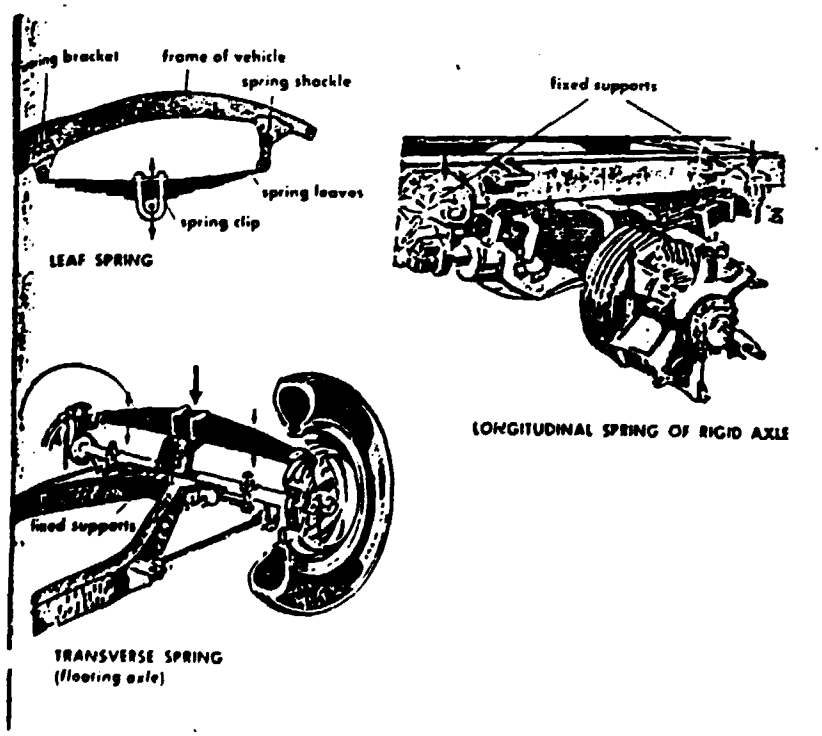
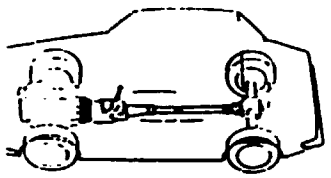

frame of vehicle
spring shackle
spring leaves
spring clip
LEAF SPRING
fixed supports
LONGITUDINAL SPRING OF RIGID AXLE
fixed supports
TRANSVERSE SPRING
(floating axle)

FIG 9
REF 4.1.9

# the clutch

## What the clutch has to do



THE PURPOSE of the clutch is to disconnect the engine from the road wheels when a car is changing gear or being started from rest. This allows a new gear to be engaged smoothly before transmission is re-engaged, or, on starting, it allows the engine to pick up sufficient speed to drive the car.

Disengaging the clutch separates three parts of the clutch assembly—the flywheel, the driven plate (also known as the centre plate or clutch plate) and the pressure plate. The flywheel is bolted to the end of the crankshaft and rotates with it. The driven plate is splined to the gearbox input shaft so that they rotate together, and the pressure plate clamps the driven plate to the flywheel.

When the pressure is released by depressing the clutch pedal, the crankshaft and gearbox input shaft rotate independently; when the driver takes his foot off the pedal, they rotate as one.

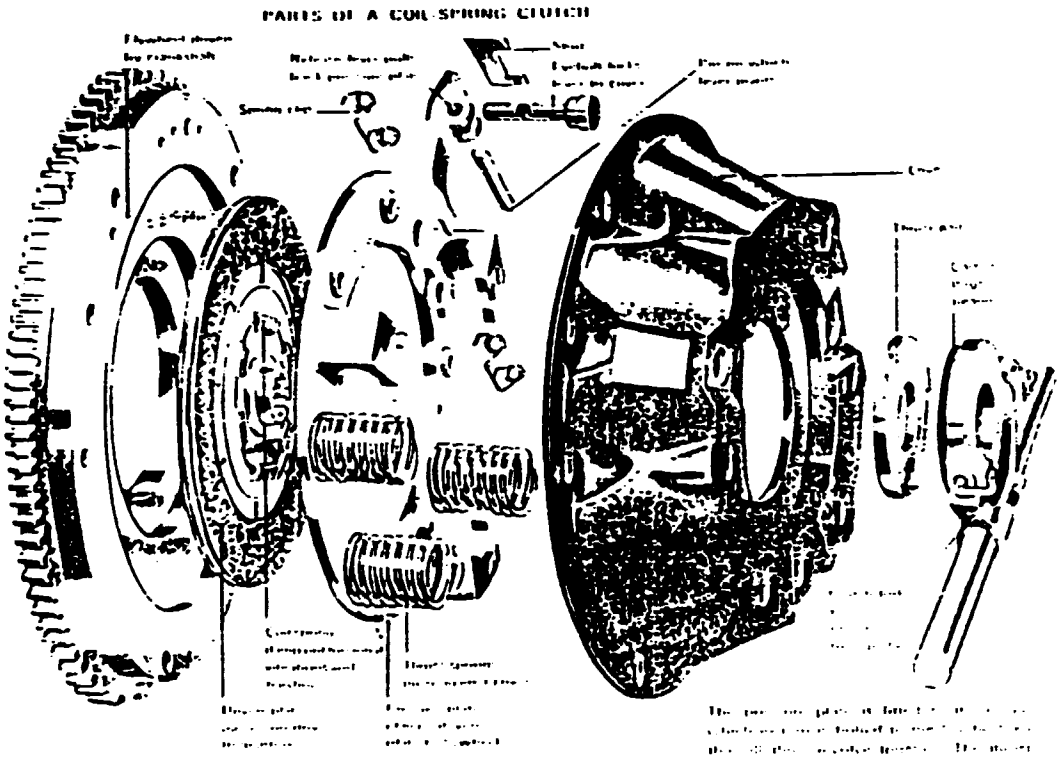
Both sides of the driven plate, a thin disc of high tensile steel, are faced with a friction material known as the lining. When the driven plate is clamped to the flywheel by the pressure plate, the clamping load must be great enough to prevent any slipping at the maximum torque delivered by the engine to the flywheel.

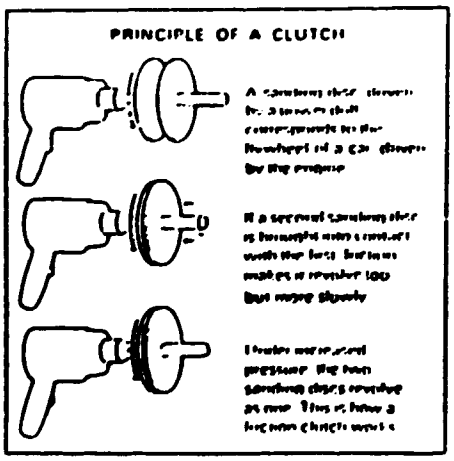
The terms coil-spring clutch, diaphragm clutch and centrifugal clutch refer to different methods of applying a load to the friction linings.

In a coil-spring clutch, the pressure plate is backed by a number of coil springs and housed with them in a pressed-steel cover bolted to the flywheel. The springs push against this cover.

Neither the driven plate nor the pressure plate is connected rigidly to the flywheel; both can move either towards it or away from it.

When the driver depresses the clutch pedal, a thrust pad, riding on a carbon or ball thrust-bearing to reduce wear, is forced towards the flywheel. Levers, mounted so that they engage with the thrust pad at one end and the pressure plate at the other, pull the pressure plate back against its springs. This releases pressure on the driven plate, disconnecting the gearbox from the engine.



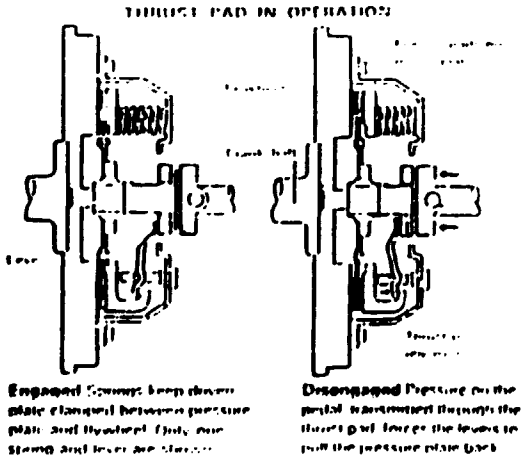




FIG 10
REF 4.1.10

## 9.0.0 ACKNOWLEDGEMENTS

The Consultant would like to place on record his gratitude and thanks to the United Nations Industrial Development Organization for giving the opportunity to undertake this Mission. In particular, he would like to thank the Feasibility Studies Branch of UNIDO for engaging the Consultant's services.

The author would also like to record his thanks to Mr. E. Galama, Substantive Officer, Feasibility Studies Branch, Department of Industrial Operations, UNIDO with whom the Consultant had the privilege to work and collaborate, for the various kinds of assistances and help during the Mission, both at Vienna and at Enugu, Nigeria. In particular, the excellent briefing at Vienna and the high quality briefing literature provided at Vienna by Mr. Galama has been of immense value which assisted the Consultant in launching the vigorous field work at Enugu, from day one. Mr.Galama's help, guidance, assistance, dialogue and discussions at Enugu have been extremely helpful in crystallising the output of earlier work into a consolidated form of results of the Mission. Furthermore, Mr.Galama's debriefing at Vienna has assisted the Consultant in a significant manner in formatting and drawing up the report. For all these and other aspects of personal significance in the course of joint work, the Consultant is grateful.
It has been very pleasurable and memorable to work with Mr.E.Galama.

The Consultant would like to place on record the very valuable guidance for the Mission given to him during the briefing at Vienna on conducting the engineering aspect of field work and information-generation to - Mr. A.A. Swamy Rao, Senior Interregional Adviser on Engineering Industries, UNIDO, Vienna. The Consultant had also the privilege to have a comprehensive debriefing with Mr.A.A.Swamy Rao at Vienna when the Consultant wished to report indepth about the results deduced from the Study Mission. The Consultant would like to place on record his thanks to Mr. A.A. Swamy Rao for giving the valuable time during debriefing.

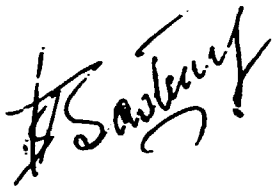
The debriefing at Vienna has helped the Consultant in framing and formatting the Report.

The Consultant would also like to thank Mr. C. Malik, a.a.R.R. UNDP, Lagos, during briefing, for guidance in matter conducting the work taking into account the national and local conditions and environment. The Consultant would like to thank Sidfa, Lagos, Ms. Mathey Boo, for her guidance during mission and careful hearing during debriefing.

The Consultant has given a list of the various officials of the Ministries of Commerce and Industries and Finance and Planning whom he met and spoke to and interviewed and to whom he is greatly thankful for assistances and valuable information and the insights provided to assist the Consultant in his field work; and the consolidation of information

generated. Some times meetings were short but provided valuable linkages to forge ahead with the intensive field work which had to be charted on spot and completed on time in tune with objective local engineering and techno-economic parameters prevalent.

The Consultant would also like to record his thanks to Mr.Engr, Chris, C.Nkwonta, General Manager, CIC and Mr. Vin. O.C.Uzowulu, Deputy Controller, CIC and other staff members of CIC.



**SOSALE. V. SASTRY**

**CONSULTANT**

**POST: UC/NIR/89/173/11-51/J 14101**

CONFIDENTIAL

10.0.0 List of Officials met and to whom the UNIDO Consultant would like to express his most grateful thanks for their assistance, help and guidance.

| No. | Name and Designation | Date of Meeting |
|---|---|---|
| 1. | Mr. Daniel Nwagu Ongele<br>Commissioner,<br>Ministry of Commerce & Industry,<br>Enugu, Anambra, State of Nigeria. | 15th and 23rd Nov. 1989 |
| 2. | Mr. Cyril O. Udoye<br>Director General,<br>Ministry of Commerce & Industry,<br>Enugu, Anambra State of Nigeria | 15th Nov & 8th Dec 1989 |
| 3. | Mr. B.N.Okafor<br>Director of Industries,<br>Ministry of Commerce & Industry,<br>Enugu, Anambra State | 23rd Nov and 9th and<br>12th Dec. 1989 |
| 4. | Mr. Mbacci,<br>Project Officer,<br>Ministry of Commerce & Industry<br>Enugu. | 24th Nov., 13th and<br>14th Nov. 1989. |
| 5. | Dr. R.E. Aneke,<br>Director of Planning,<br>Ministry of Finance & Economic Planning,<br>Enugu. | 27th Nov. 1989<br>8th Dec. 1989 |
| 6. | Mrs. Agbo<br>Deputy Director,<br>Ministry of Finance & Economic Planning,<br>Enugu | 8th, 13th and<br>14th Dec. 1989 |
| 7. | Dr. E.M. Gbanite,<br>Director, Small Scale Industry<br>Development Fund,<br>Ministry of Industries,<br>Enugu | 13th and 14th Dec 1989 |
| 8. | Engr Chris C. Nkwonta,<br>General Manager,<br>CIC, Enugu | 5th Nov 1989 to<br>14th Dec 1989 |
| 9. | Mr. Vin O.C.Uzowulu<br>Deputy Controller,<br>CIC, Enugu | 15th Nov 1989 to<br>14th Dec 1989 |
| 10. | Other Officials and Non-officials as referred to in the report. | |

## 11.0.0 LIST OF REFERENCES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3. AED — (Africa Economic Digest) London - Special
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4. Feasibility Study on Passenger Cars Assembly and Local
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Frankfurt - Report for UNIDO, Vienna

5. UNIDO Opportunity Studies by Beldo & Co., Italy (Counter part
NIDB) Interim Report for Engineering Industries
Sub Sector - 1989.

6. Technology Report on Selected Indian Automotive Ancillary
Industries - 1978 Nov by Automotive Research
Association of India to Industrial Credit and
Investment Corporation of India, Bombay.

7. "Investment Potentialities in Anambra State"
Natural Resource Base - Raw Materials
Pub. Anambra State - Publn. June 1987

8. Five Feasibility studies on Manufacture of Selected Automotive
spare parts - report by Mr.E.Galama dated
15 December 1989

31st March 1990

ANNEXURE TO THE

REPORT

BY
THE UNIDO CONSULTANT IN AUTOMOTIVE SPARE PARTS
DEVELOPMENT AND MANUFACTURE

ON

ASSESSMENT AND PREFEASIBILITY STUDIES WITH
A VIEW TO IDENTIFICATION OF AUTOMOTIVE
SPARE PARTS FOR MANUFACTURING IN ANAMBRA STATE
OF NIGERIA

ENTITLED

"LIST OF COMPANIES AND INSTITUTIONS RELATED TO AUTOMOTIVE
SPARE PARTS PRODUCTION OR RESEARCH IN ANAMBRA STATE
VISITED AND PERSONS MET WITH"

BY

S.V. SASTRY
CONSULTANT
BANGALORE 560004-INDIA

POST NO. UC/NIR/89/173/11-51/J 14101

SEPERATELY SUBMITTED TO: Mr. E. GALAMA
FEASIBILITY STUDIES BRANCH
DEPARTMENT OF INDUSTRIAL OPERATIONS
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
VIENNA INTERNATIONAL CENTER
VIENNA - AUSTRIA

ANNEXURE

"LIST OF COMPANIES AND INSTITUTIONS RELATED TO AUTOMOTIVE SPARE PARTS PRODUCTION OR RESEARCH AND PERSONS MET WITH"

| No. | INSTITUTION/ ADDRESS NAME/DESIGNATION | DATE OF VISIT |
|---|---|---|
| 1. | Standards Organization of Nigeria<br>Enugu, Zonal Office<br>Mr.O.A.Otisi<br>Head of Enugu Zonal Office<br>(Being Out of Town, after the visit, I held discussions with Librarian and other Supporting officials) | 21st Nov.1989 (Tuesday) |
| 2. | Union Trading Co.<br>Station Road<br>Enugu<br>(Garage Chain Specializing in Peaugots)<br>Inspection of Service Methodology, Facilities<br>Persons Met: Foremen and Supervisory Staff) | 23rd Nov,1989 (Thursday) |
| 3. | Levantis<br>Enugu<br>(Garage Chain, Specialising in Mercedes Benz)<br>Inspecton of Service Methodology, Facilities<br>Persons Met: Foremen and Supervisory staff) | 24th Nov,1989 (Friday) |
| 4. | Dr.Hans Juergen Ahlbrecht<br>Managing Director<br>M/s Anambra Motor Manufacturing Co. Ltd, ANNAMCO.<br>(Daimler Benz Buses and Trucks)<br>Emene - Enugu<br>(Not Available) | 28th Nov 1989 (Tuesday) |

| | | |
|---|---|---|
| 5. | Mr.Godfrey Chike Oniya<br>Company Secretary<br>and Asst. to Mg.Director<br>M/s ANNAMCO<br>Address as above. | 28th Nov 1989<br>Tuesday |
| 6. | Mr. Roland Mueller<br>Production Engineering/<br>Control Manager<br>M/s ANNAMCO<br>Address as above. | 28th Nov.1989<br>Tuesday |
| 7. | Engr. P.A.C. Amechi<br>Rector<br>Institute of Management<br>and Technology<br>I M T<br>Enugu<br>(Not Available<br>Directed to Dy.Rector) | 28th Nov,1989<br>Tuesday |
| 8. | Dr.G.C. Ezimora<br>Deputy Rector and<br>Chairman of Consultancy Center<br>Institute of Management and<br>Technology, I M T<br>Enugu | 28th Nov.1989<br>Tuesday |
| 9. | Mr. J.N.Uba<br>Associate Professor<br>and Secretary of Consultancy Center<br>Institute of Management and<br>Technology, I M T<br>Enugu | 28th Nov.1989<br>Tuesday |
| 10. | Mr.Annammah<br>Officer incharge of<br>Central Facility of<br>Industrial Center<br>and Lecturer in Mechanical Engineering | 28h Nov.1989<br>Tuesday |
| 11. | Mr.N.N.Azikiwe<br>Executive Director<br>Emene Motors<br>Emene, Enugu<br>(Agents for Peaugots) | 30th Nov.1989<br>Thursday |

| | | |
|---|---|---|
| 12. | Mr.Remi Adenyi<br>Manager, Offshore Funded Sales<br>Tractor & Equipment Division<br>of U A C of Nigeria Ltd<br>(Agents for Caterpiller)<br>Billingsway,Oregan Industrial<br>Estate, Ikeja, Nigeria<br>(Visiting Enugu to oversee<br>and review Caterpiller Service<br>Operations in Anambra & Enugu)<br>(Discussions in depth) | 18th Nov.1989<br>Saturday |
| 13. | Mr.Dipo Ogunmola<br>Area Parts Sales Representative<br>Tractor and Equipment Division of<br>U A C of Nigeria Ltd. (Agents for<br>Caterpiller)<br>2, Okpara Avenue, Enugu<br>(Inspection of service facility) | 30th Nov.1989<br>Thursday |
| 14. | Mr.Sunday Ugwu<br>Production Manager<br>M/s Godwin Chris Auto Spare Parts Co.<br>Umudim, Owerri Road<br>Nnewi<br>(Company Suggested by M/s C.I.C) | 5th Dec.1989<br>Tuesday |
| 15. | Mr.Onwuka<br>Administrative Manager<br>M/s Cento Group of Companies<br>NKWO Village Site<br>Iyaba, Umudin, Nnewi<br>(Company Suggeted by M/s CIC) | 5th Dec.1989<br>Tuesday |
| 16. | M/s Uru Industries Ltd.<br>122, Owerri Road<br>Akwu Ura Industrial Estate<br>Nnewi<br>(Suggested by M/s CIC)<br>(Factory Visit and discussion<br>not permitted by the<br>company after calling in) | 5th Dec. 1989<br>Tuesday |

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| 17. | M/s Mabros Industries Nigeria Ltd<br>at Duoma/Umunna Amakwa<br>Ozubolu<br>(Suggested by M/s C.I.C)<br>(Could not be located or<br>reached) | 5th Dec.1989<br>Tuesday |
| | (Note: Additionally M/s CIC had indicated M/s John White Industries Nnewi, Resources Improvement Maf. G.Nnewi and Ibeto Industreis Nnewi They were discussed with Mr. Uzowulu and agreed that they were not within the purview of present studies as explained in PP 40-41-42 of main report) | |
| 18. | Mr. E.C.Kalu,<br>Depot Chief<br>Nigerian National<br>Petroleum Corporation<br>Emene, Enugu<br>(Sub for discussions<br>Dieselization, availability<br>of Petro Chemical based raw<br>materials for auto industry) | 7th Dec.1989<br>Thursday |
| 19. | Engr.E.O.Kaine<br>Director<br>Projects Developments Institute<br>(Proda)<br>Federal Ministry of Education<br>Science and Technology<br>Independence Layout<br>Enugu<br>(Very long telephonic<br>conversation and dialogue) | 7th Dec.1989<br>Thursday |
| | P.S: | |
| | (NOTE KINDLY THAT THE LIST OF OFFICIALS MET HAS BEEN GIVEN UNDER ITEM NO. 10.0.0 ON PP 111 OF MAIN REPORT) | Annexure<br>over<br>S.V.SASTRY |

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