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RESOURCE CONSERVATION THROUGH PREVENTIVE MAINTENANCE IN THE NIGERIAN ALUMINIUM METAL FORMING PI ANTS

by

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ABSTRACT

One of the concerns of the Nigerian Aluminium Industry is the reduction of manufacturing expenses in a market where serious competition is beginning to set in either with aluminium products or competing alternative products made from steel or plastic. Although the Nigerian aluminium demand forecast in the near future appears to be bright, even in the face of global slow down in consumption, the positive growth will (to a large extent) be sustained by products which are competitive with good quality. This paper is concerned with a section of this industry – the metal-forming plants – which is currently the fastest growing sector numerically. It highlights the upkeep of some of the main machinery type through preventive maintenance.

INTRODUCTION

Aluminium paradoxically, has rather short history. Though it forms about 8% of the earth's crust and is third most plentiful element known to man, the technology to produce it was developed less than a century ago. However, it has compensated for its late start by the swiftness of its development. It has found application in many areas such a packaging, transportation, Building and Construction, consumer goods, aerospace and ordnance, machinery and equipment, etc. and presently it is second to steel (among engineering metals) in its worldwide use measured by weight, volume and monetary value (8).

Despite the fact that West Africa (mainly Guinea) has about one-third of the world proven bauxite reserve the region remains one of the lowest aluminium consumers except for the Nigerian market that is showing rapid growth over the last two decades. This growth is largely due to the rapid economic growth and the seeming ease of obtaining aluminium semi-finished and finished products as a result of increasing number of fabricating plants.

ALUMINIUM FABRICATING IN NIGERIA AND NEED FOR MAINTENANCE

From small beginnings of aluminium fabrication for kitchen utensils in the early 1960's the industry has grown numerically. In the early 1960's there were only two small factories making

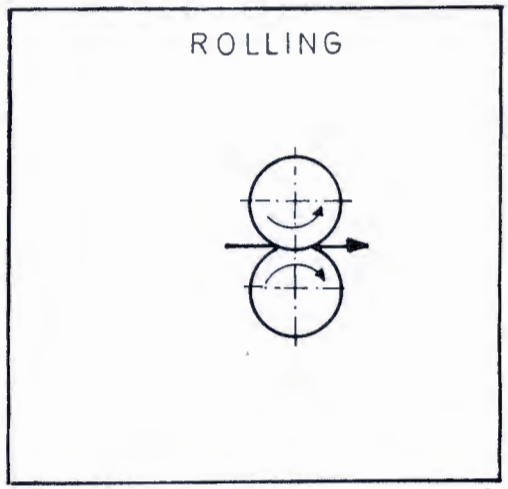
kitchen utensiles but today there are two rolling mills, two hot extrusion plants supplying a substantial portion of the semi-finished products, which were normally imported. The volume of locally produced finished items are ever increasing. These are mainly collapsible tubes for creams, toothpaste and drugs; roofing sheets, consumer goods such as kitchen utensils, etc. The holloware plants are the fastest growing sector of this Nigerian Industry, numerically speaking. There could be as many as thirty or more plants scattered all over the Federation though most of which are very small producers of spun kitchenware. This is so because of the low capital required. The building and construction sector is another fast growing sector again because of the relatively low capital and especially because of the ease in the transformation of the coils into the required profiles.

Aluminium demand has grown over fourfold over the last one and half decades. Just before the Civil War, in 1966 consumption was estimated at about 10,000 metric tons (see Table 1) but increased almost fourfold a decade later. The aggregate consumption presently is estimated at about 40,000 to 50,000 metric tonnes.

Table 1 Source: Ref. 10

Total Aluminium Apparent Consumption for Nigeria

Year	Adjusted	Finished Product	Total
1966	5764	5620	11,384
1967	5111	(5620)	10,731
1968	3582	4315	7,897
1969	5510	907	6,417
1970	7566	(1000)	8,566
1971	10298	2645	12,943
1972	9203	2770	11,973
1973	10290	2951	13,241
1974	13339	(3000)	16,339
1975	35261	5408	40,669
1976	22716	9113.4	31,829
1977	31461	12347	43,808
1978	26546	14231	40,777



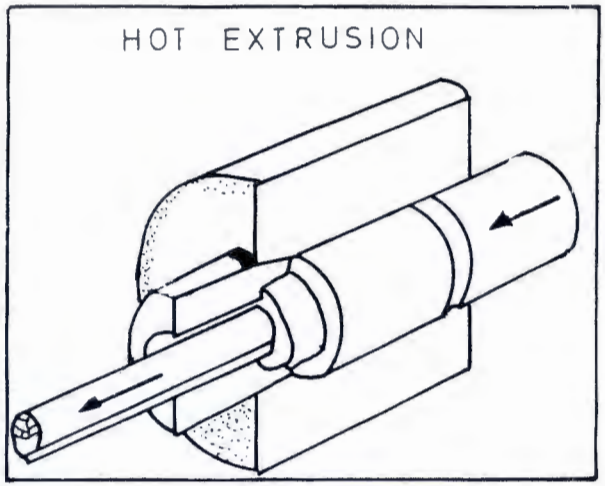
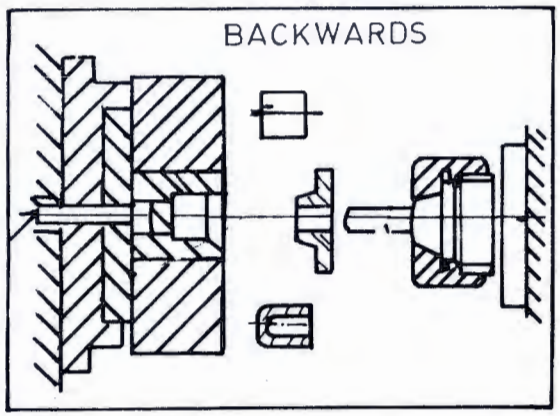
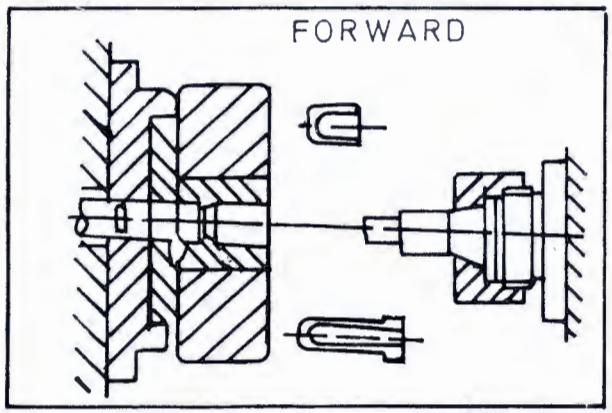
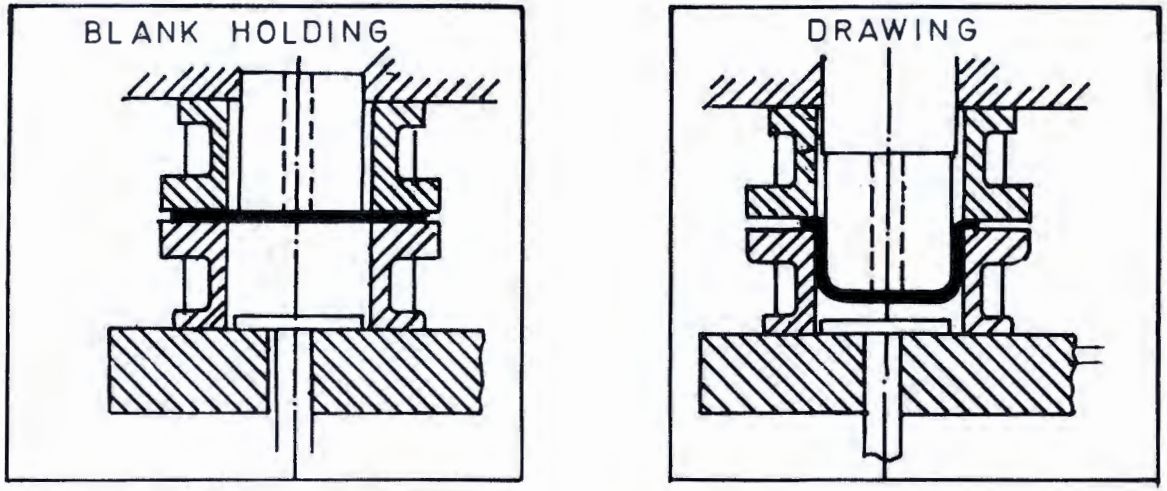


FIG.1 SOME SEMI FABRICATING PROCESSES





COLD (IMPACT) EXTRUSION



DEEP DRAWING

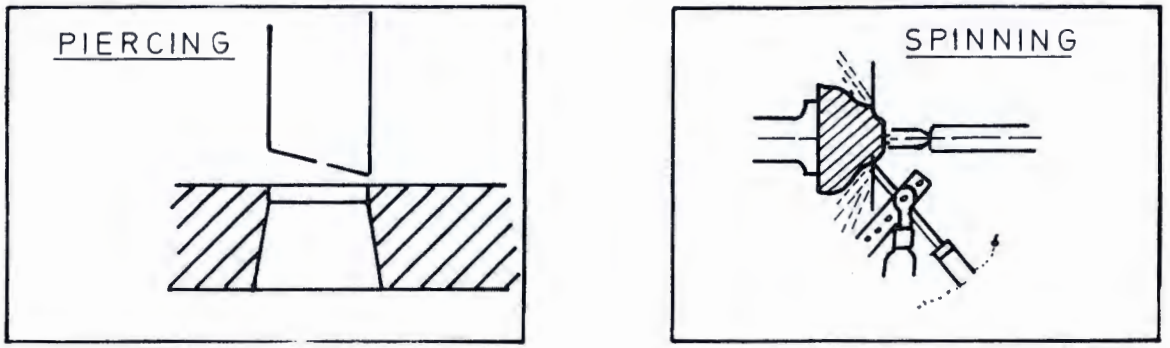


FIG.2 SOME METAL FORMING PROCESSES

At the turn of the next century in 2000A.D. aggregate demand is estimated to be distinctly above 190,000mt. which represents an increase of 300-500% over the present consumption (10). In terms of foreign exchange if all 50% of the primary ingot is produced locally (assuming a100,000mt smelter is constructed) and 80% of the semi-finished and finished products are also produced locally, the net savings of foreign exchange is in the neighbourhood of a quarter of a billion Naira or more. Downtimes due to breakdown, the non-availability of spareparts and accident regretably are regular features of our manufacturing plants today. In the aluminium industry the demand on the scarce equipment, material and wages is quite high. A slight reduction in the capacity and labour utilization represent a relatively colossal loss of revenue. In many of our plants the cause of downtime could largely be attributed to poor maintenance. In aluminium packaging, some of the operations could required high degree of precision. Bad lubrication usually leads to excessive wear, eroding the close tolerance needed to maintain that precision. This in turns leads to off standard setting and poor quality products as well as loss of expensive production time and money needed to rectify them. Closely allied to wear is the question of overall machine life; the replacement cost represents a significant drain on our scarce foreign exchange. Other benefits include cleanliness, safety and marginal savings in power cost. Good preventive maintenance will play significant part in the conservation of these scarce resources and there is a clarion need for workable preventive maintenance vigorously backed by all levels of management in our manufacturing plants. Just before discussing scheduling of preventive maintenance in our metal forming plants it will be necessary to make a very brief review of some of the aliminium metal forming process and machinery commonly used in Nigeria.

PRODUCTION PROCESSES AND MACHINERY

The broad classification of Aluminium fabrication include rolling, forging, and hot extrusion and aluminium metal forming could be grouped into blanking, piercing, contour roll forming, deep drawing, hot drawing, spinning, shear forming, flow forming, impact extrusion or cold extrusion. Other forming work could be by press brake, drop hammer, stretching, rubber, electrohydraulic or electromagnetic process. In Nigeria, the common forming process on aluminium are deep drawing, spinning, contour roll forming, impact extrusion, blanking and piercing. Fabrication of semi-finished products are largely by rolling and hot extrusion. Very little of casting and forging is being done.

In rolling, hot slabs are passed between cylindrical rolls under pressure which reduces the thickness to sheets and further reduction in thickness is effected by cold rolling. But in hot extrusion, heated billet is forced through an orifice or die from which it emerges in the required cross sectional shape. Depending on the alloy, temper, thickness width of the finished products, rolled aluminium can be used for a variety of applications ranging from circles for kitchenware, to heavy plates for vans and even used for architectural shapes for building and construction (Fig. 1). Cold extrusion or impact extrusion involves putting the starting raw materials, called slugs or preforms, under sudden pressure from a punch shoulder, thereby causing the slug to flow in the required direction (forward, backwards or both direction in relation to the punch (Fig. 2). Deep drawing, blanking, piercing, spinning, shear and flowing are illustrated in Fig. 2. Contour roll forming is done normally by working the stock (or coil) progressively in several roll stations equipped with roller dies until the finished shape is produced.

Sheet metals are drawn in either mechanical or hydraulic punch presses. Double action presses are commonly required for deep drawing and single action mechanical presses are used for blanking and piercing. In Nigeria, almost all the punch presses are mechanical. Mechanical press brakes are used for forming relatively long, narrow parts for architectural works. Spinning is done by simple

hand spinning lathes though in some of the large companies semi-automatic lathes are used. Flow forming is carried out in flow forming machines. The nucleus of cold extruded metal containers is the press.

PREVENTIVE MAINTENANCE SCHEDULING

The objectives of preventive maintenance in Aluminium forming shop must be clearly defined and supported by all levels of Management. The primary objective should be to ensure the reliability of machines thus decreasing downtime, increasing productivity but at the sametime decreasing maintenance costs. It should be noted that the main difference of preventive maintenance with planned maintenance lies in the inclusion of detailed preventive inspection which have to be carried out between the planned service dates. This could be quite expensive in terms of labour cost and production time.

In view of this the following points must be emphasized Firstly, preventive inspection should be applied selectively.

For inspection guidance, equipment should be classified but the classification should not be too rigid, the priorities setting is a problem that should be fully discussed with production. Machinery could be classified as follows:

CLASS A: Machines whose breakdown will be very costly resulting in widespread interuptions to production, emergency expenses and high mechanical repair cost.

CLASS B: Those whose breakdown are primarily a matter of high mechanical repair expenses.

CLASS C: Low cost machinery with no direct tie in the general production shedules.

Examples of Class A machines in typical Nigerian Aluminium fabricating shop are Punch Presses, Hot and Cold Extrusion Presses, Casting and Annealing Furnaces in Aluminium Rolling Mills and Boilers for process heating where used. Class B machines could be semi-automatic spinning and polishing machines and Class C could be manual arbor presses, kick rivetting machines, etc. It should be pointed out again that the demarcation line is not rigid but depends largely on the importance of a piece of equipment to the production schedule. Secondly, preventive maintenance schedule should be based on facts and statistically proven frequencies. Also a thorough review of equipment should be made with intent to discover possible point of failure and the means of eliminating them.

Thirdly, the effectiveness of the system depends on the type of personnel running it. There is a need for trained and qualified personnel, supervised by a leader who is both competent and effecient with a background and working knowledge of metal working machinery. It does not mean that he should have perfect knowledge of mechanical, electrical and lubrication engineering but he must have workers who have these capabilities.

For mechanical punch presses an experienced millwright is a must especially in Nigeria where the foreign exchange cost could be extremely high to replace presses. Other important members of such team is a competent electrician and a person knowlegeable in lubrication especially in large packaging plants where it could be complex. Lubrication, paradoxically, is an area that is most overlooked in many Aluminium fabricating plants.

LUBRICATION

In organising plant lubrication it will involve most of the following:

a) Selecting the proper lubricant. In Nigeria, many of the Oil Companies will give expert advice on suitable lubricant if invited.

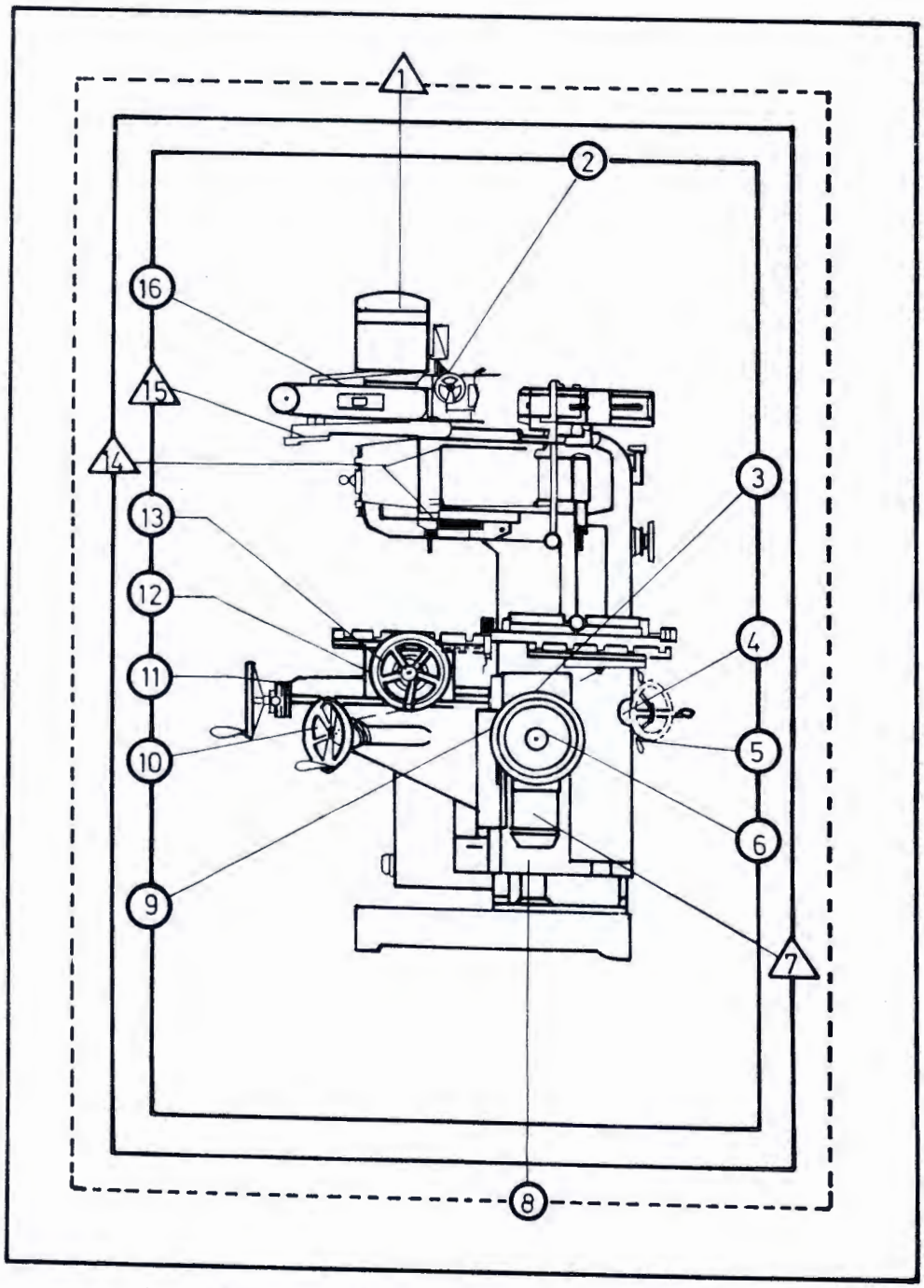


FIG. 3 A LUBRICATION DIAGRAM IN WHICH THE FRAMES REFER TO DIFERENT PERIODS OF SERVICE AND THE CIRCLES AND TRIANGLES TO THE TYPE OF SERVICE (REF.14).

b) The frequency of application should be determined by previous experience though guided by suggested frequency from Oil Company.

c) In preventive maintenance, lubrication schedules and the instructions relating to them should be detailed and specific. Lubrication diagram such as in the Fig. 3 should be used especially for the presses.

d) Lubrication record should be simple, free of complexities and take as little time as possible to keep.

e) Review storage, handling and application procedure to reduce wastage, deterioration and labour time.

f) In Aluminium metal forming plant, responsibility for lubrication should rest on a senior person such as the maintenance engineer or plant engineer.

INSPECTION

A system can be called "preventive maintenance" only if all possible steps are taken to ensure continuous trouble free operation. To ensure trouble free operation between planned services, clearly defined inspection checklists should be prepared and maintained. An example of a checklist for preventive punch press inspection is shown below (Ref. 12).

TABEL 2 SOURCE: REF. 12

MACHINE NO. _____ TONNAGE _____ TYPE _____

STROKE _____ S.P.M. _____

SHUT HEIGHT _____ S/N _____ MAKE _____

INSPECTED BY				
DATE				
CONDITION				
I. CLUTCH & BRAKE A. Mechanical				
B. Air Friction Linings				
Springs				
Packings				
Seals				
Pressure Sw.				
II. DRIVE Crankshaft				
Main Gears				

Pinions				
Main Brgs.				
Conn. Brgs.				
Flywheel Brgs.				
Keyways				
Flywheel Brake				
III. SLIDE				
Gibs				
Liners				
Adj. Screw				
Adj. Nut				
Pitman				
Wrist Pin				
Ball & Seat				
IV. BED				
Cushions				
Ways (Ext.)				
V. C'T BAL. CYL.				
Packings				
Piston & Rod				
Pressure Sw.				
VI. TIE ROD & NUTS				
VII. LUBRICATION				
Oil Lines				
Fittings				
Supply				
VIII. ELECTRICAL				
Panel				
Relays				
Wiring				
Palm Buttons				
"V" Belts				
Motor-Main				
Mortor-Slide Aj.				

Motor-Lube				
Foot Pedal				
IX. AUXILIARY EQUIP. Air Blow-off				
Pull Backs				
Barrier Guards				
K.O.				
Feeds				
Straightners				
Reels				
Scrap Choppers				
Conveyors				

Even in medium size, aluminium fabricating plant the preventive inspection could be enormous and there will be need for a type of 'memory core' to initiate these inspection. A 'tickler file' (Ref. 14) is an excellent system to use. It is simply a box with cards carrying the instruction and recording of work done on all the machines. The box is divided into twelve months of the year and when a certian job has been done it is moved back within the set to a spot representing the date of the next service.

STORAGE, SETTING AND PREVENTIVE MAINTENANCE OF TOOLS

The working life of tools, for example draw tools depends on the storage practice, the experience and care of the tool setter and how careful and regular the care of the tool surfaces.

It is advisable to store the last workpiece manufactured by a tool with the tool itself so that faults in the tool, such as scratches, can be noted and corrected in good time. The store should have adequate space and labels to facilitate storing and retrieval.

Tool setting should not be done hastily and before operation, all moving parts must be checked for smooth and close operation and tolerances. Good foundations and secure installations protect the machine from vibration and assist in lengthening the life of the tools.

Careful attention should be paid to the maintenance of tools. In many processes carbide die are used, say for ironing (or reducing). A carbide die is an expensive precision tool which with proper care, will produce at least ten times as many pieces per grind as a high-carbon, high-chrome die of comparable quality (17). Appropriate die handling and service tools should be used. Die should not be left wet or left overnight in grinder as some water soluble coolants etch the cobalt binder out of carbide.

Although proper care of die is essential premature failure of die can be avoided by proper tool design and materials selection. This is particularly important for companies who are now producing their tools locally.

CONCLUSION

As the demand for aluminium products continue to rise at relatively higher rate than most African countries, the need to conserve our already overburdened foreign reserve becomes despara-

tely urgent. A slight reduction of imports by increased local output by good capacity utilization and plant availability is very much welcome. Furthermore a slight reduction in the prices through the reduction in the manufacturing cost is invaluable in promoting the so much talked about diversification of non-oil exports. A good preventive maintenance practice in our ever increasing aluminium metal forming plants would make some contribution in conserving our scarce resources. To carry out an effective preventive maintenance thorough equipment inspection should be installed based on statistically proven breakdown frequencies especially on the machines very vital to production. Thorough lubrication arrangement should be made and the qualified personnel should be engaged.

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