ANNUAL REPORT

ON

HANDPUMP TESTING IN UPPER LIVULEZI PROJECT

IN MALAWI

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1. Background

The handpump testing and monitoring programme under the UNDP/World Bank Global Project for Field Testing and Technological Development of Rural Water Supply Handpumps is being carried out in an area called "the Upper Livulezi" situated in Ntcheu District in Malawi. This area is a valley through which the Livulezi River flows. The Project area is about 180 square kilometers, with a population of about 50,000 scattered among 90 villages. The only sources of clean water supply for the villagers are the boreholes and dug wells in the Project area.

In the Project area, there are 201 water points fitted with different types of deep-lift and shallow lift-handpumps. Two maintenance assistants from the Water Department of the Government of Malawi are living in the Project area, each looking after 100 pumps. They are provided with bicycles to move around in the field and with the basic tools needed to carry out repairs.

2. Types of pumps monitored during 1985

(a) Deep Lift: 99 Maldev Pumps. (Malawi)

23 India MK II pumps. (India)

13 Consallen pumps. (U.K.)

In August 1985 two of the above Consallen pumps were replaced by Afridev pumpheads along with plastic downhole components supplied by Consumers' Association Testing and Research in the U.K.

(b) Shallow Lift: 57 Mk V Pumps (Malawi)

10 Madzi/Blair Pumps (Malawi)

In August 1985, 7 Mk V pumps were replaced by 6 Tara pumps (Bangladesh) and 1 PEK pump (Canada), and 1 Blair pump was replaced by 1 PEK pump.

3. Maldev Pump

Development of the Maldev pump started in 1981 and various prototypes were designed and built. After several months of building prototypes a set of drawings were prepared in January 1982 for a pre-productions run of 25 pumps. These pumps were built by Lilongwe Mechanical Development Limited without any jigs and fixtures and many problems were encountered due to assembly faults. 22 of these pumps were installed in the Livulezi Project between April and June 1982.

In the meantime, drawings were prepared for a full scale production run and a full range of jigs and fixtures were built for pumphead assembly and quality control. 77 of these production units, with greatly improved quality, were installed between 1982 and November 1983.

The Maldev pump incorporates three 6204-2RS, rubber sealed ball bearings, two in the handle and one in the hanger. Due to poor quality control in manufacturing of the first 22 pre-productions units, more bearing failures have occurred during the field trials than with the "Production" Maldevs. For example the holes on the handle for fulcrum bearings were not properly aligned and also the parts were not interchangeable.

According to figures 1 and 2, the fulcrum bearings had to be replaced in about 10% of the pumps and in another 10% of the pumps the hanger bearings had to be replaced during their 18th-24th month operation. Fig 5 shows that 20% of the total number of pumps have had either hanger bearings or fulcrum bearings replaced in their 18th-24th month of operation. As shown in Fig.6, by the end of the 36 months of operation, 52% of the total number of pumps had either hanger or fulcrum bearings replaced for the first time. When analysing the breakdown records there were only two occasions where all three bearings (one hanger and two fulcrum) had to be replaced at the same time or within the same period of six months taken for plotting the histograms. Therefore Fig. 5 is the addition of Fig. 1 & 2 and Fig. 6 is the addition of Fig. 3 & 4.

As indicated in Fig. 5, there is a peak between the age of 18th-24th month of the pumps showing 20% of the pumps needed bearing replacements. At the age of 36 months only 52% of the total population of the pumps have had bearing replacements. It would be interesting to draw the histogram for the first bearing replacement of the other 48% of the pumps with the information collected in future. These data could be used for maintaining stocks of bearings in projects.

Fig.7 shows that five pumps had to have either hanger or fulcrum bearings replaced (3 with fulcrum and 2 with hanger) for the second time during their 24th-30th month in operation. According to Fig.8 only 7% of the total number of pumps had to be replaced by either hanger or fulcrum bearings (2nd time) before completing an operational period of 36 months (3 years). All of these eight bearings which had to be replaced for the second time were fitted on site.

In the Maldev pump there is a severe drawback in the design. Once the bearings are badly worn the balls can fall inside the pump head and fall down the rising main into the cylinder. They jam inside the cylinder and damage the piston seals and the cylinder. Several cases of this type of damage to downhole components have occurred in Livulezi.

The maintenance assistants are replacing the worn bearings of the Maldev pumps on site. There are no proper tools for removing the worn out bearing or for fitting the new bearing on to the handle or hanger. The worn bearing is hammered out from it's housing with a hammer or a flat spanner. This tends to damage the bearing seat when a blow misses it's target. The new bearing is hammered into the housing in the same manner, which may damage the new bearing.

I designed and fabricated some simple tools for this process. There are three circular metal pieces to remove the worn bearing. If the complete worn bearing is in place the appropriate piece (small one) is screwed on to the "base" piece and used.

P. 1 Using the new simple tool to install a new bearing in the hanger.

A. The three circular cylindrical metal pieces.

B. The wooden block to hold the hanger.

C. The wooden block to place between handle forks.

When the bearing is badly worn the balls are lost and only the outer ring remains in the housing. In this case the larger circular piece is screwed on to the "base" piece and used. This tool is placed on the worn bearing and tapped with a hammer to remove it. The same process is used to install a new bearing. There are two wooden blocks, one to suppport the hanger and one for placing between the forks of the handle when removing the bearings. All these items can be carried in the maintenance assistant's bag of tools.

When the figures for failures of bearings replaced on-site (i.e. following first bearing failure) are analysed they show that:

(i) 6% of the bearings fitted on site failed between 0-6 months of operation.

(ii) another 6% failed between 6-12 months of operation.

(iii) another 4% failed between 12-18 months of operation. Therefore a total of 16% of the bearings fitted on site failed before 18 months of service.

It is expected that these figures could be brought down with systematic fitting of bearings using the new simple tools.

Fig. 9 shows the first piston seal replacement in the Maldev pump. It shows a fairly equal distribution over the different ages of the pumps and according to Fig.10. 30% of the pumps had to have the seals replaced within the first 36 months of use. Second piston seal replacement in the pumps, shown in Fig. 11, has a similar distribution as for the first (Fig.9).

4. Breakdowns and failures in other test pumps

4.1 India Mk II pump

Twenty three (23) India Mk II pumps have been under test in the Livulezi Project since May 1982. Nine (9) of these pumps were installed between May - December 1982 and the rest between January - October 1983. The first breakdown connected with the pump head appeared in February 1986 when the pump rod fastening to the roller chain failed. This was mainly due to worn threads on the pump rod. The internal threads of the socket attached to the roller chain were also showing signs of damage.

Out of the 23 India Mk II pumps only 8 have standard India Mk II downhole components,i.e. 12 mm galvanised steel pump rods, 32 mm GI rising main and a 63 mm brass cylinder, all from India. Since December 1982 to date there have been no breakdowns connected with these downhole components except for a corroded rising main pipe.

4.2 Consallen Pump

Consallen pumps have given a lot of problems in connection with their plastic rising main. The breakage of the rising main pipe at its threads has been the most common cause of breakdown. As shown in Fig. 13 this type of breakdown had occurred at a maximum rate of 70 breakages per 100 pumps during the 6th to 12th month of operation of the pumps. This rate had fallen with time to 22 breakdowns per 100 pumps at the 30th - 36th month of operation of the pumps.

In 1985 a few breakages of the rising main occurred. Once the cylinder had to be changed due to a leaking foot valve. On two occasions the complete handle was replaced due to worn fulcrum bearings.

P.2 Failure of pump rod to handle connection in the Mk V shallow well pump.

4.3 Mk V Pump

Breakage of the pump rod at the connection to the handle is the most common failure in the Mk V pump. The 25 mm uPVC pump rod is solvent cemented to a uPVC bush at the end of the metal handle. A "head" is made on the pump rod so that the PVC bush can enter inside the pump rod and then be joined with solvent cement. The pump rod usually breaks at the neck of it's "head". A solution has been tried using a rubber coupling between the uPVC pump rod and handle. Problems with this connection are firstly that the moulded-in brass female sockets in the rubber tend to come out and secondly that the threaded part at the end of the handle breaks off due to insufficient strength. At the moment a new type of connector is being tested which is manufactured at Pipe Extruders Ltd. in Malawi. Fig 14 shows the rate at which the pump rod to handle connection failed during each part of the year starting from April 1983.

There have been several cases of plungers breaking away from the pump rod at the solvent weld connection. A new type of plunger which could be screwed on to a socket which is solvent-cemented to the pump rod is being tested at present. A new type of footvalve which is manufactured at Pipe Extruders is also being tested along with the new plunger and pump rod connection.

4.4 Blair Pump

The most common failure in this pump is breakage of the rising main near the handle. During 1985 this occurred three times on the pump at water point No. GP 12 and once on the pump at water point No. SW60. The other significant failure was breakage of the outer uPVC pipe at its top threads where it is screwed to the adapter union on the slab. This occurred twice on the pump at water point No. GP 19. Fig. 15 shows how often this common failure of breakage of the rising main at it's connection to the handle has occurred with the ten Blair pumps tested. From the declining pattern of the graph it shows that the frequency of the failure has decreased with the age of the pumps.

4.5 Tara Pump

Six Tara pumps have been installed in the Livulezi Project since August 1985. All of these have been installed on shallow wells and the cylinder settings of the pumps are between 4.5 - 5.5 m. This pump has good design features such as extractability of the foot valve with the help of the pump rod, low cost, and a wooden bush which can be made from locally available material, as the bearing and guide for the handle.

However, poor quality of manufacturing has led to several problems with the pump. Three pumps experienced failures, with the pump rod breaking away from the handle within six months of installation. The pump rod has a threaded metal stud at the its end and it is screwed into a threaded hole at the end of the handle. These internal threads are of a poor quality and fail easily.

The other common problem with the Tara is that the pump rods fill with water. This is due to inadequate sealing of the pump rods at their ends. When the pump rods are filled with water the pump is extremely heavy to operate. Therefore pump rod buoyaney which facilitates pumping is lost and the pump becomes unacceptable to users.

The quality of wood used for the bush is not very good, and it tends to wear out rapidly. When the hole is enlarged plenty of water comes through the wooden bush and splashes, wetting the user's clothes and feet, and often making the surroundings of the pump very muddy.

The piston seals (cup leathers) are also of poor quality. The piston seal in one pump was completely destroyed within two months of installation. The rubber flaps of the foot valve and piston tend to come out of their locating grooves after a few months of use.

4.6 PEK Pump

Two Pek pumps have been installed in the project area since October 1985. One is installed in a borehole (GP 19) with a cylinder setting of 9 m and the other in a shallow well (SW 46) with a cylinder setting of 5 m. There has been only one breakdown since installation of the two pumps. At GP 19 the aluminium pump rod became disconnected from the handle in February 1986, due to failure of the crimped rod connection. It was reconnected by re-crimping the aluminium rod onto the connector. Users are generally happy with the PEK pump but complain about the very low flow rate.

5. Testing and Development

5.1 Plastic Bearings

As described earlier, the Maldev pump uses three ball bearings (6204.2RS), two for the handle and one for the hanger. The current retail price of a bearing of this type is about Kwachas 12.00. Therefore it is fairly expensive for villagers to replace the bearings of their pump once in two or three years. In addition, replacing the bearings in the Maldev pump needs skill. To remove the handle, the hanger has to be disconnected from the handle. To remove the hanger when using conventional, non-extractable downhole components, the pump head has to be removed. Replacement of the bearings in the hanger and fulcrum housing has to be done with care. (K12 = US$ 7.2).

When compared to ball bearings, plastic bushes are extremely cheap (cost of the four bushes is expected to be around 12 Kwachas) and easy to replace. With the modified Afridev pumphead shown in the photograph, replacing the four plastic bushes in the pumphead could be done by a person in a village. Therefore, development of the plastic bearings, assuming they prove to be successful, is a major step towards Village Level Operation and Maintenance of handpumps.

P.3 Replacing the plastic bearings of the hanger unit in the "Afridev pumphead.

In the Livulezi Project, three boreholes are fitted with prototype Afridev pumpheads which can accommodate polyacetal bushes (PV 80) working on stainless steel pins as bearings for handle and hanger. There are 4 identical bushes, 2 in the handle fulcrum and 2 in the rod hanger. The water points at which these plastics bearings are tested are:

	Depth (m)	S.W.L (m)	CYL Sett. (m)	P.W.L. (m)
1. GP 33	26.27	9.37	21	11.81
2. GP 111	30.50	15.00	27	18.81
3. GP 22	45.80	21.50	42	40.00

In GP 33 the present set of bushes have been in operation since August 1984. Fig. 16 shows the rate of wear on the bushes. The wear pattern of the bushes roughly follows a straight line and from the figure it is clear that wear rates are different for each bush although the conditions are similar.

When the wear curves for GP 33 and GP 22 are compared (Fig. 16 & Fig. 17), the rates for the fulcrum bushes are quite similar, but the rate for hanger bushes on GP 33 is much higher than for those in GP 22. But it would be expected to be the other way round, because the load on the hanger bearing of GP 22 is much higher than on the same in GP 33, due to a deeper water level and cylinder setting.

A new set of polyacetal bushes were installed on the hanger at GP 11 in March 1985. Each of these bushes has four longitudinal grooves on their working surfaces.

Earlier it was suspected that the dust collected inside the bush accelerates the rate of wear of the bush. The grooves provided can accumulate the dust so that the working surfaces can remain free of dust particles. Fig. 18 shows the wear rate of these new bushes on the hanger. Fig. 19 shows a comparison of the wear rate of the earlier (without grooves) and current (with grooves) polyacetal bushes on the hanger unit in GP 111. It certainly shows an improvement in performance of the current, grooved bushes.

Since August 1985 two other combinations of plastic bearings have been tested in Livulezi Project. At the water point No. GP 142 a modified Afridev pumphead is installed with Delrin 500 CL bushes working on Zytel 101 sleeves as a bearing for hanger and fulcrum. At the water point No. GP 68 another modified Afridev pumphead is installed with Delrin 500 CL bushes working on pins sleeved with Zytel. It is too early to measure significant wear on both of these systems.

5.2 Use of PVC as a rising main material in borehole handpumps

Ten boreholes were installed with PVC pipes as rising mains in the Livulezi project in 1982 and 1983. A few of them were removed subsequently due to problems connected with the pumping cylinder assembly. Presently, seven boreholes fitted with uPVC rising mains are in operation.

75 mm Class 10 pipes are normally used for the rising main pipe in boreholes, and these are manufactured locally by Pipe Extruders Ltd., in accordance with the Malawi Bureau of Standards MBS - 4. The pipes are supplied in 6 m lengths, and are connected with spigot and socket joints using solvent cement. In the Maldev pump this rising main is suspended by a rubber cone compressed between two steel plates on the base of the pump stand.

Most of the uPVC rising mains installed have been in for 2.5 to 3 years without problems, at installation depths of 20 to 30m. The advantages of uPVC rising mains are:

1. Light and easy to handle.

2. Less expensive than steel rising mains.

3. Chemically inert, thus they can be used in corrosive groundwater.

5.3 CATR Downhole Components

Seven sets of new CATR linked plunger and footvalve assemblies made from engineering plastics have been installed in the Livulezi Project, starting from August 1985. So far there have been no problems with the plunger body and the footvalve but there have been a few occasions where the piston seals have had to be changed. Generally the performance of the Hallite polyurethane seal installed with these new CATR plungers is not good. It wears rapidly and the volumetric efficiency of the pump seems to fall quickly compared to the conventional cup leathers currently used in the Maldev pump.

If the CATR pistons and footvalves prove to be successful in their tests it will be another big step towards a VLOM pump. Its advantages are:

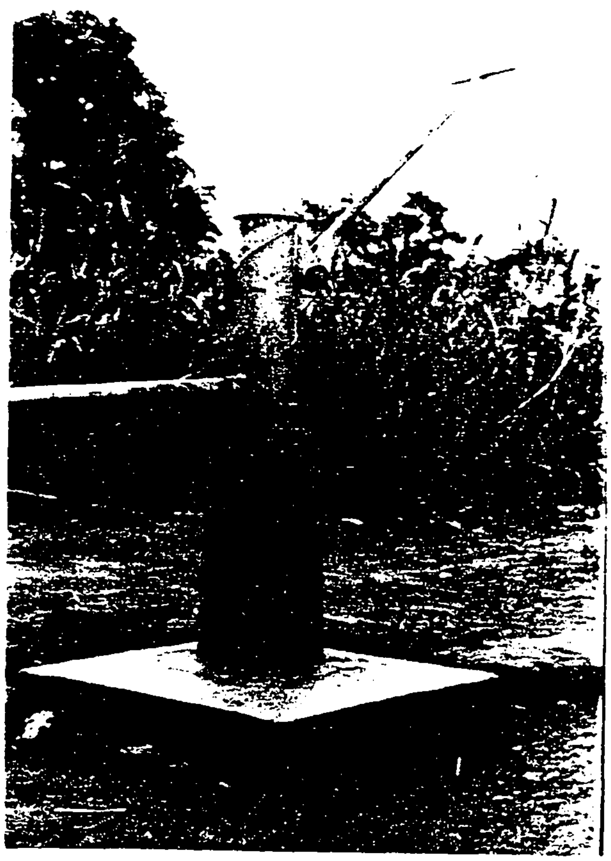
1. Easy extractability of the plunger as well as the footvalve (linked) through the pumphead. The only part that has to be removed for this operation is the pumphead top cover plate.

2. Replacement of the plunger seal or rubber 'O'rings for the plunger and footvalve can be done extremely easily. No tools are required for this except for a coin or screw driver with which the snap-fitted plastic parts of the piston or footvalve can be dismantled.

   Therefore, compared to replacing the piston seals in a conventional brass cylinder, this operation is relatively simple, with no particular skills being required.

5.4. Concrete Pedestals for the Maldev Pump

Two concrete pedestals were built in the Livulezi Project in August 1985. (The Photograph shows a Maldev pumphead mounted on a concrete pedestal). A metal frame made out of small angle iron sections or with a 6" m.s. pipe welded on to a square m.s. flange is embedded in the concrete and provides



P.4 Maldev pumphead installed on a 'Concrete' pedestal.

mounting for the pump head. The mixture of concrete used is 1:2:4. The cost of the concrete pedestal is around K40 (US $25.0) and the present price of the steel pedestal for the Maldev pump is K88 (US $52.0). Therefore a large saving can be made if these concrete pedestals prove to be successful in the tests.

6. Measurement of Water Quality and Volume Pumped

6.1 Water Quality Analysis

A complete analysis of the quality of water in the Livulezi Project was done at the Central Water Laboratories recently. 168 water points were sampled including almost all the boreholes and some shallow wells. Generally the groundwater quality complies with WHO standards for drinking water. The results of analysis are attached to this report.

Another purpose of this analysis was to find out whether there is any contribution to the iron content in water from the mild steel down-hole components of some of the pumps. The outcome of this study will be presented in a report shortly.

6.2 Water Meters

In August and September 1985 water flow meters were installed at 10 water points in the project. Many problems were encountered, mainly due to mal-functioning of the meters. The meters tend to block very easily if the water contains tiny sand or rust particles. Unlike a pipeline installation, there is no up-stream pressure for the meter in a handpump. When particles accumulate inside the chamber with the rotating lobe the meter stops functioning.

The water then starts to spill through the holes in the pumphead and the users get no water until the maintenance assistant cleans the meter. The surroundings get very dirty and muddy in such cases. At the start the meters had to be changed from one water point to another to find the ones with particle-free water, and different sizes of meters had to be installed to find the most suitable size.
One inch meters are working satisfactorily at water points with a static water level of 8-12 meters.

The figures for consumption of water from meters vary widely from day to day. The figures for the wet season obtained from the meters show an average of 5 cubic meters per day for 250 users.

7. Maintenance Costs

There are two Project Maintenance Assistants living in the Livulezi Project area, carrying out the maintenance work for all the two hundred pumps installed. They use bicycles for their work travelling as far as 15 miles each way to the furthest water point. Since heavy spanners cannot be carried on a bicycle, villagers (mostly women) go all the way to the Maintenance Assistants' houses to collect the heavy spanners and any spares needed, such as pipes required for the maintenance work.

P.5 Woman and children carrying spare parts and tools needed to maintain their pump from maintenance assistant's house.

Recently some calculations were done to find out the cost of maintenance for each type of pump installed in the project. They give the following figures averaged over the last three years of operation of the Project. Direct total cost of maintenance per pump per year is calculated as follows:

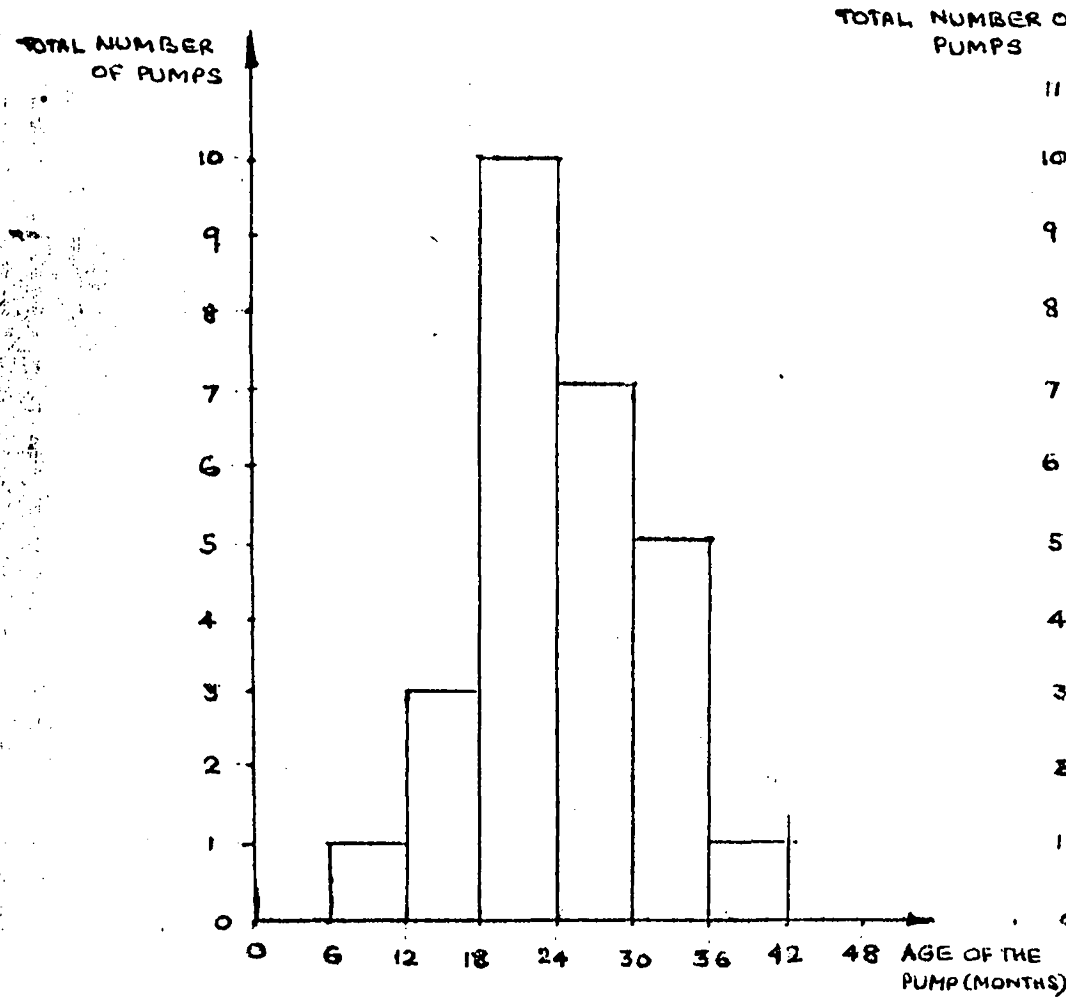


FIG 1. FIRST FULCRUM BEARING(S) REPLACEMENT OF MALDEV HANDPUMPS.

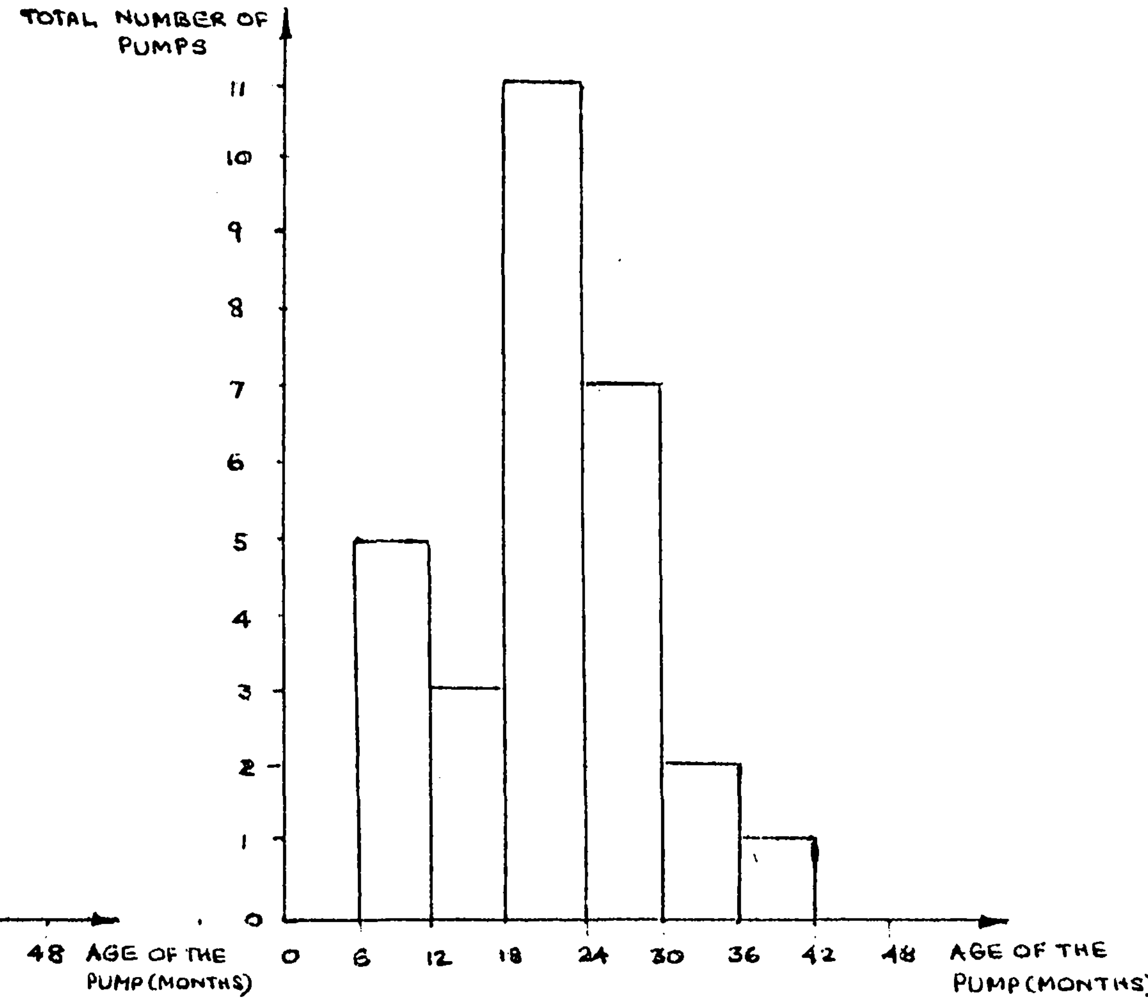


FIG.2 FIRST HANGER BEARING REPLACEMENT OF MALDEV HANDPUMPS.

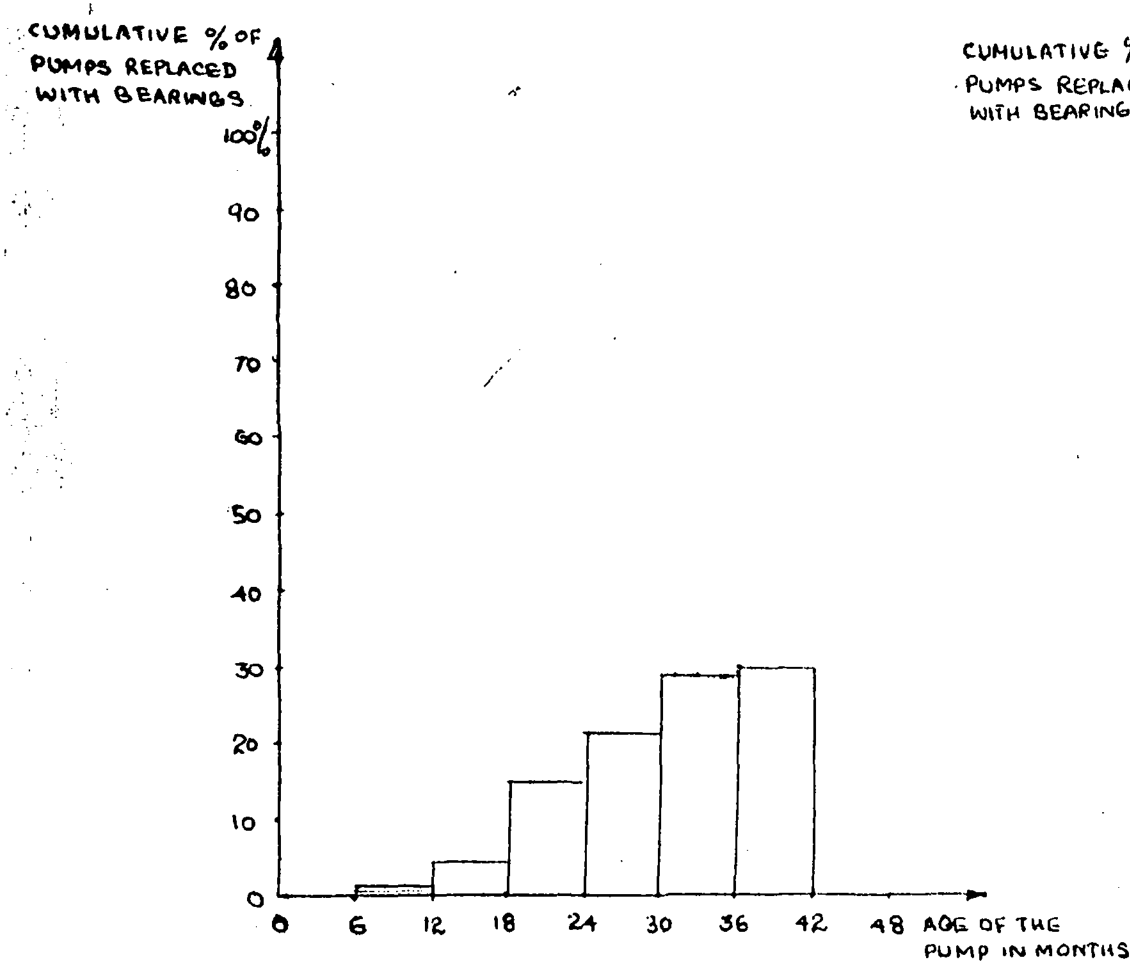


FIG. 3 FIRST FULCRUM BEARING(S) REPLACEMENT IN MALDEV HANDPUMPS

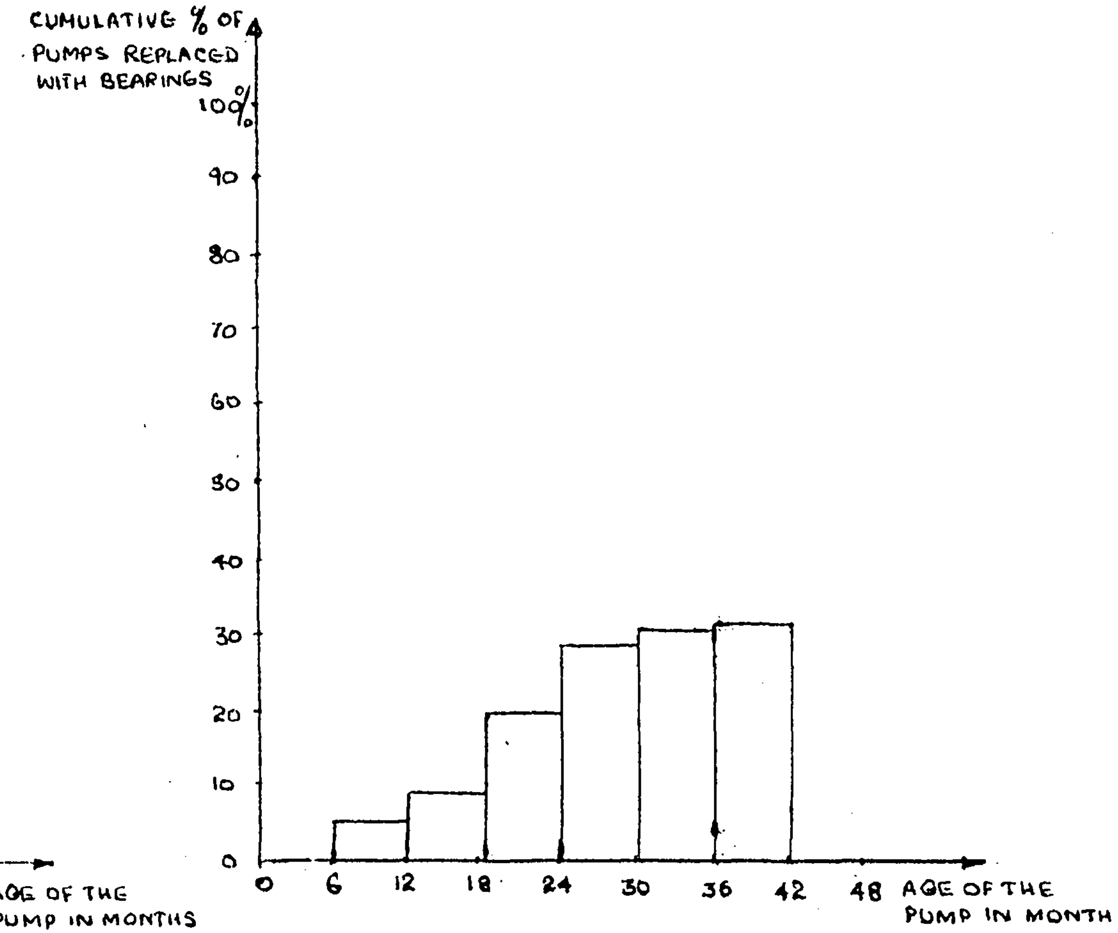


FIG. 4 FIRST HANGER BEARING REPLACEMENT IN MALDEV HANDPUMPS

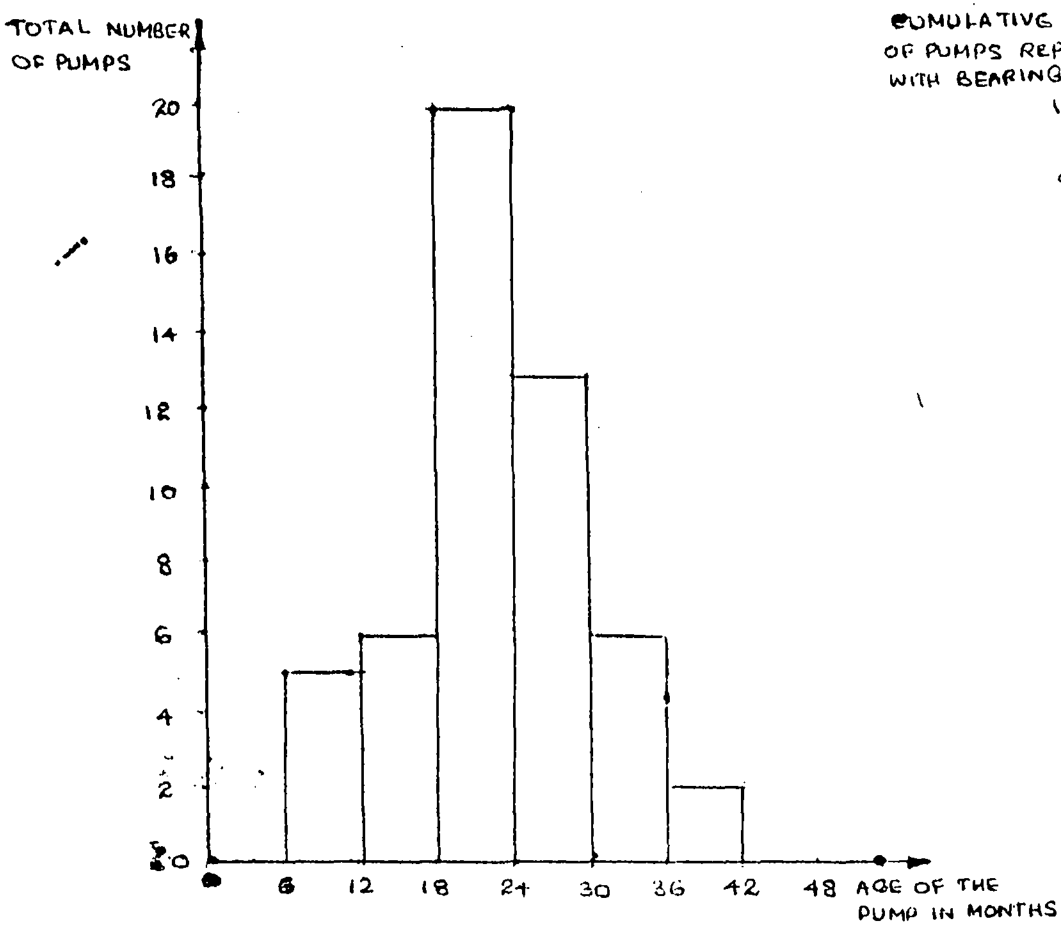


FIG 5. FIRST BEARING(S) REPLACEMENT IN MALDEV HANDPUMPS (HANGER & FULCRUM)

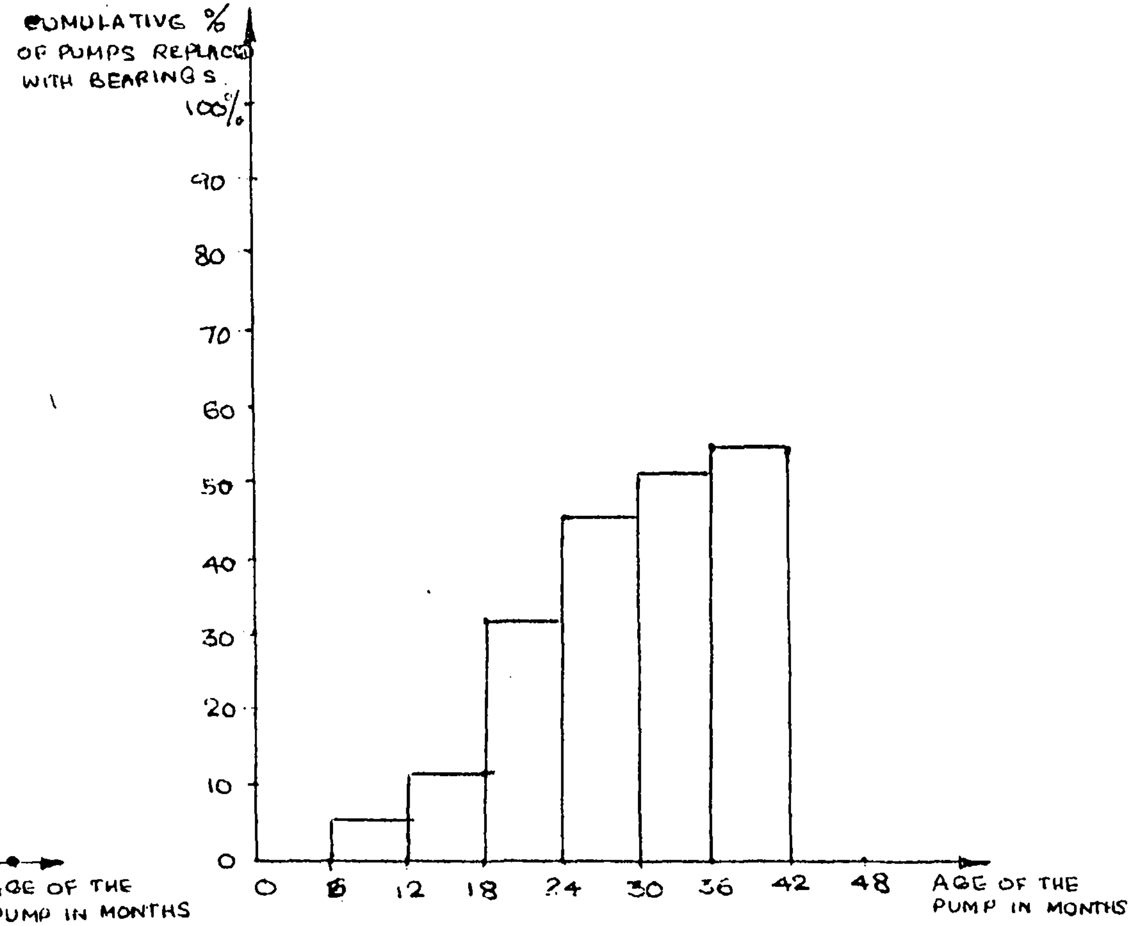


FIG. 6 FIRST BEARING(S) REPLACEMENT IN MALDEV HANDPUMPS. (HANGER & FULCRUM)

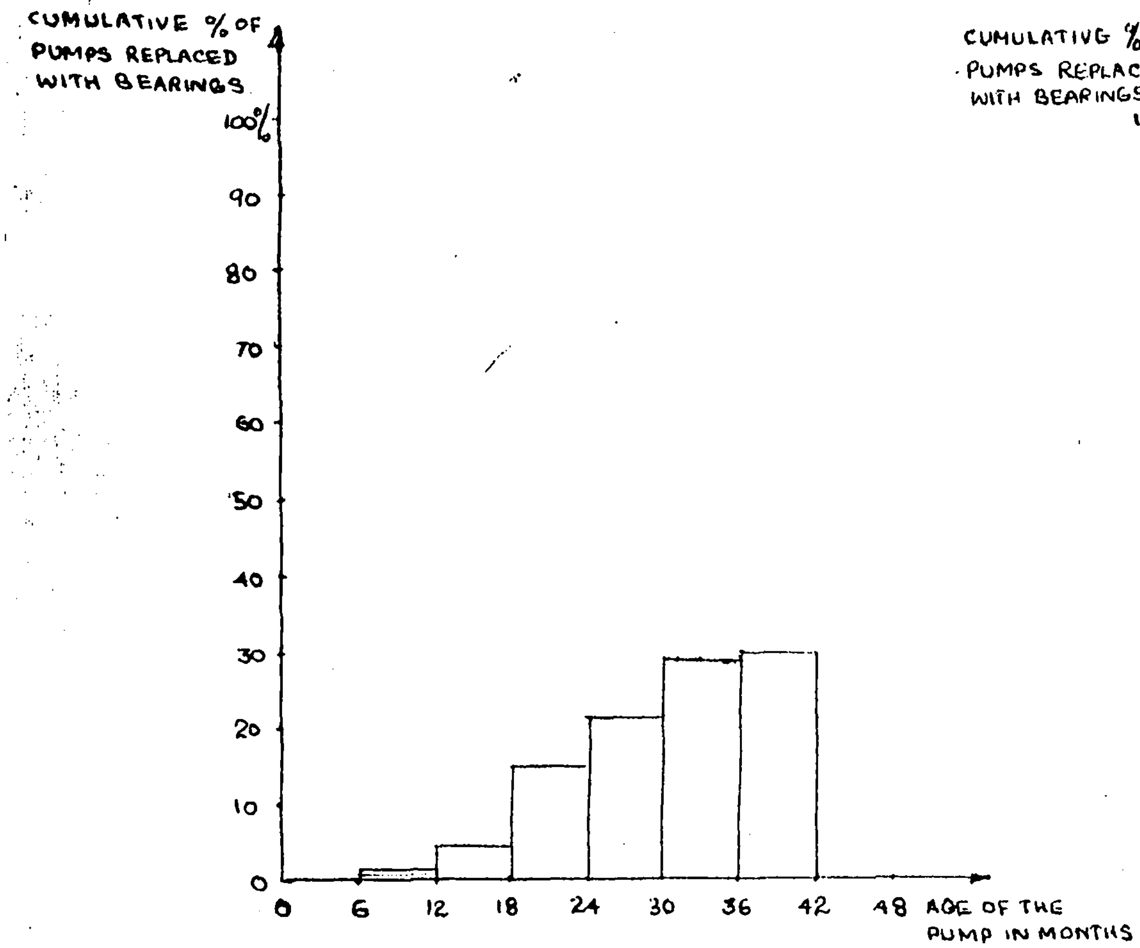


FIG. 3 FIRST FULCRUM BEARING(S) REPLACEMENT IN MALDEV HANDPUMPS

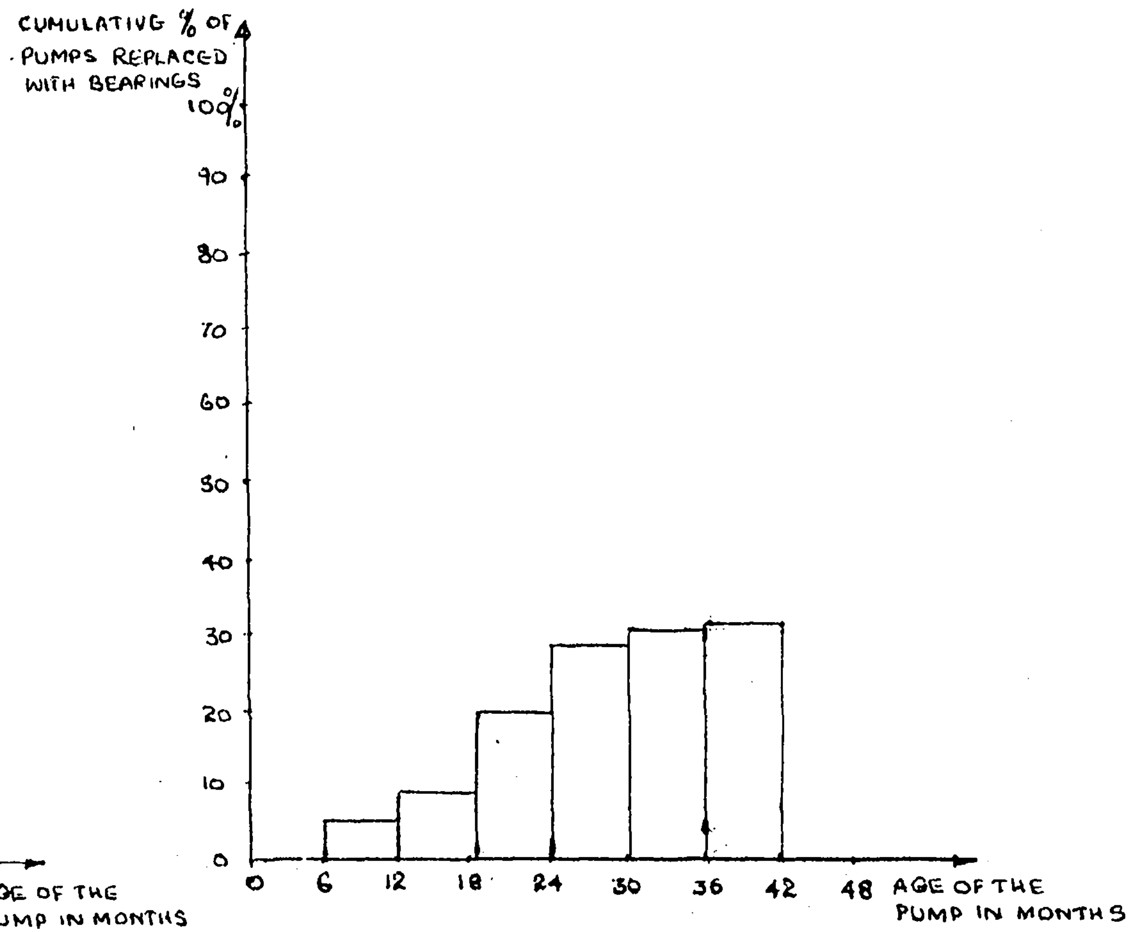


FIG. 4 FIRST HANGER BEARING REPLACEMENT IN MALDEV HANDPUMPS

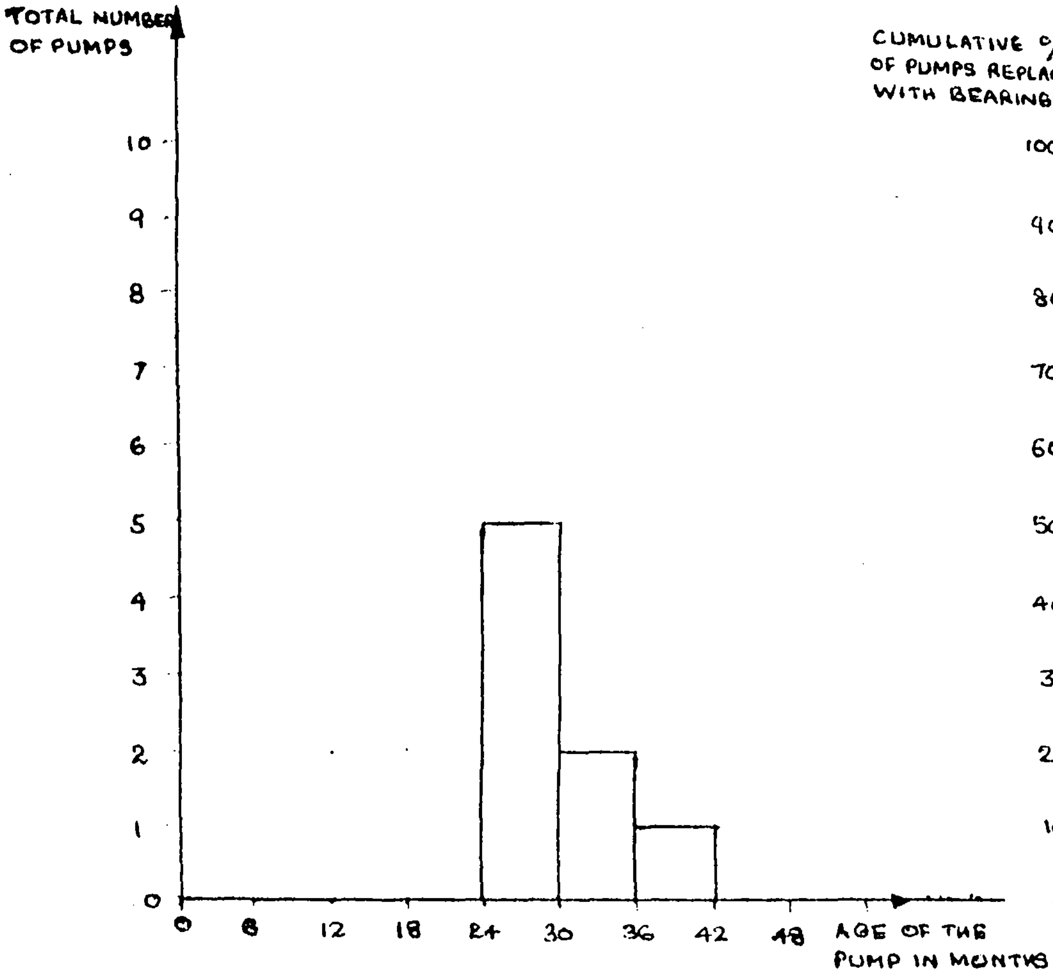


FIG. 7. SECOND BEARING(S) REPLACEMENT IN MALDEV HANDPUMPS

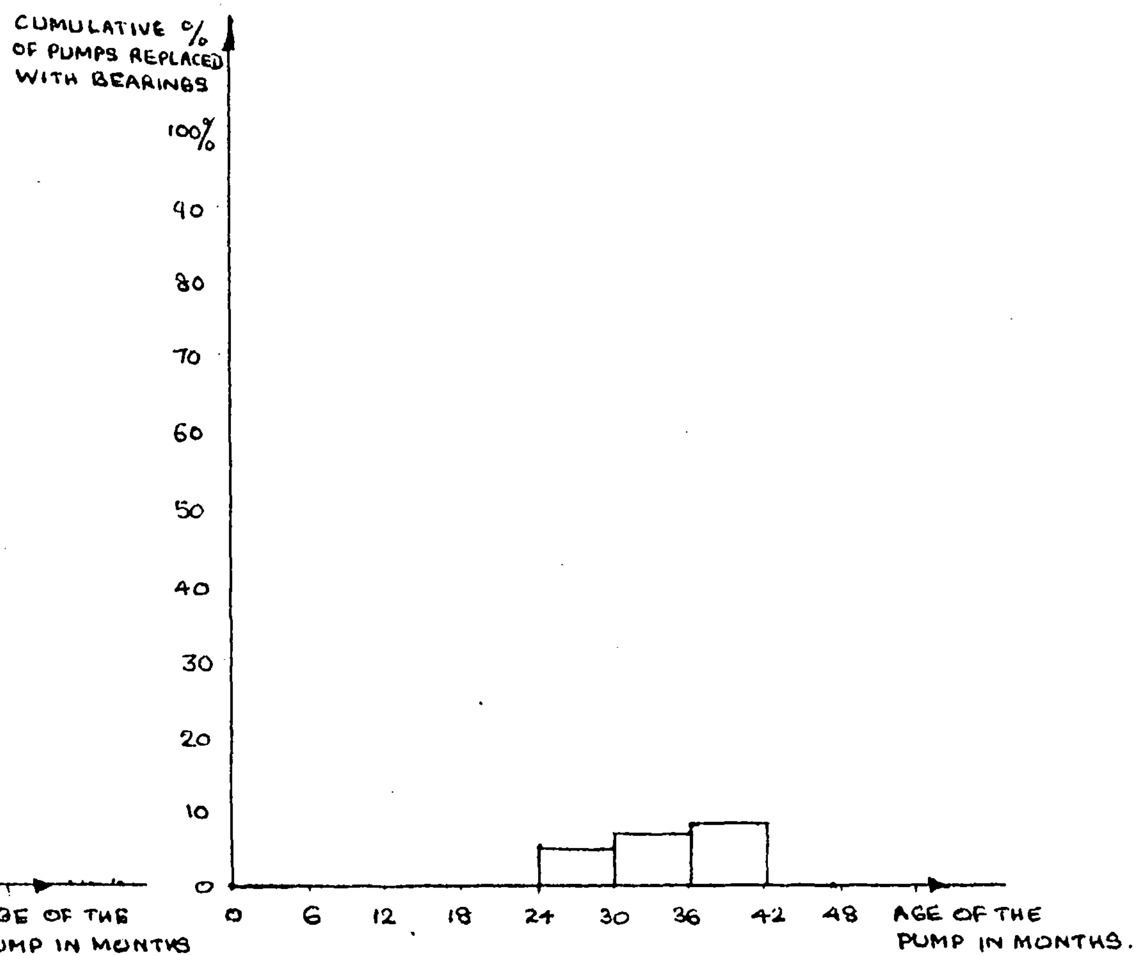


FIG. 8. SECOND BEARING REPLACEMENT IN MALDEV HANDPUMPS.

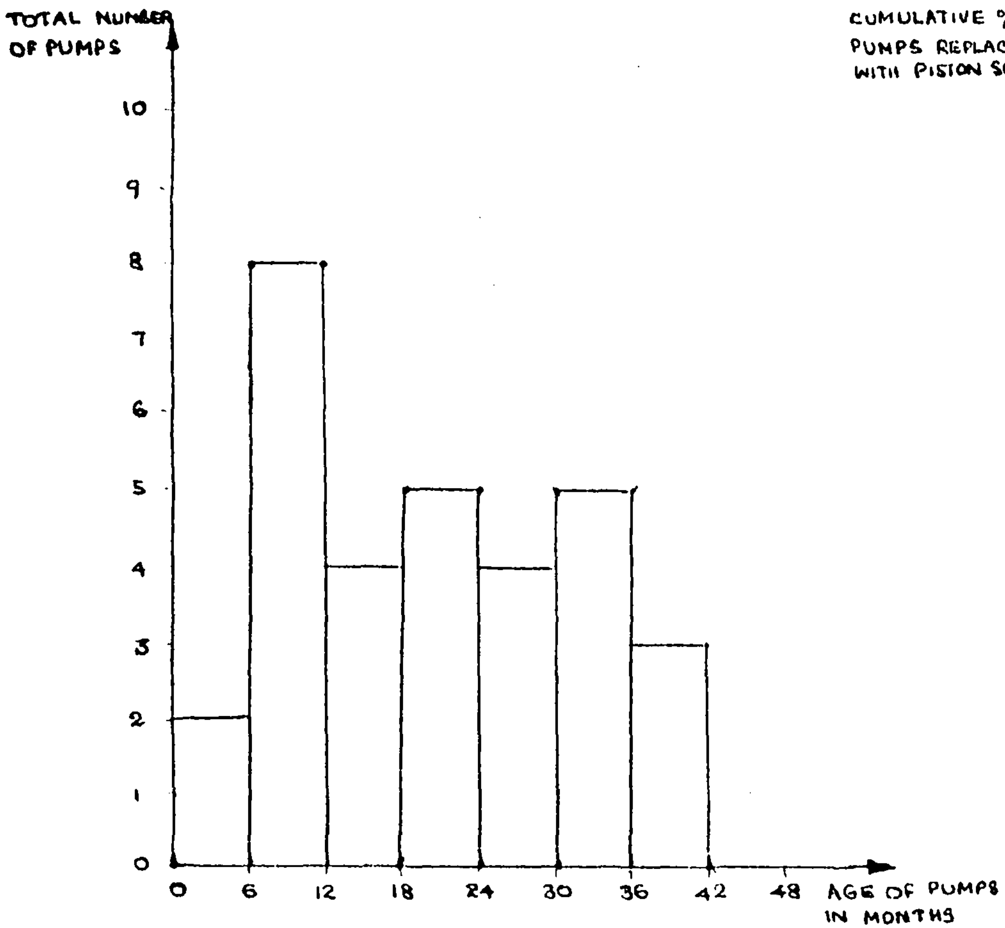


FIG. 9 FIRST PISTON SEAL REPLACEMENT IN MALDEV HANDPUMPS.

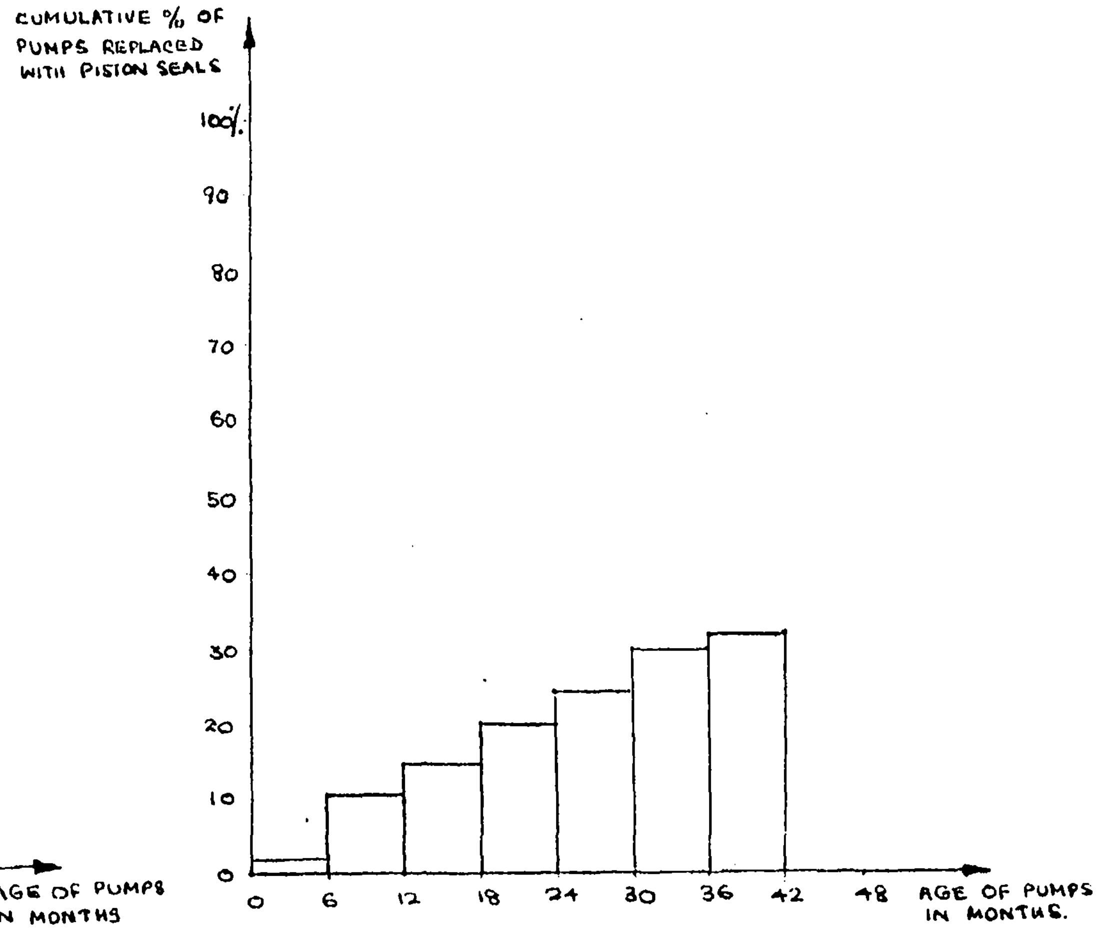


FIG. 10 FIRST PISTON SEAL REPLACEMENT IN MALDEV HANDPUMPS.

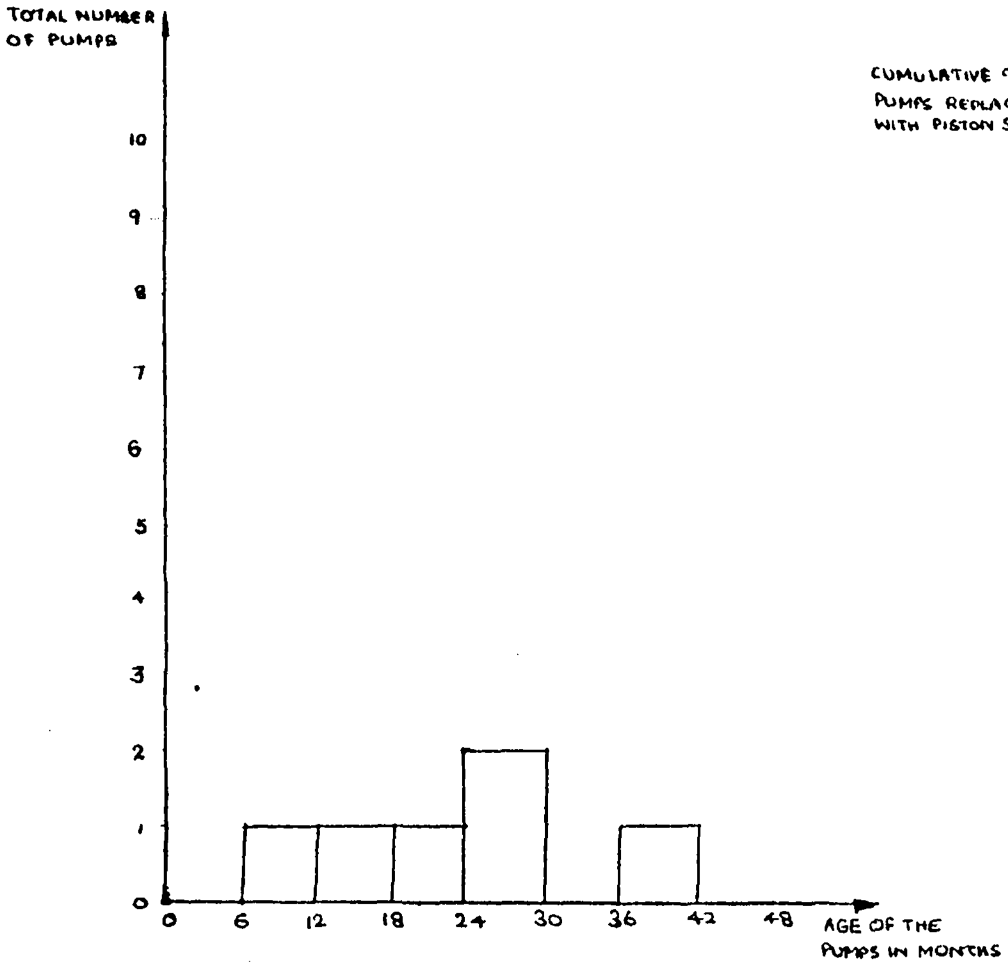


FIG. 11 SECOND PISTON SEAL REPLACEMENT IN MALDEV HANDPUMPS

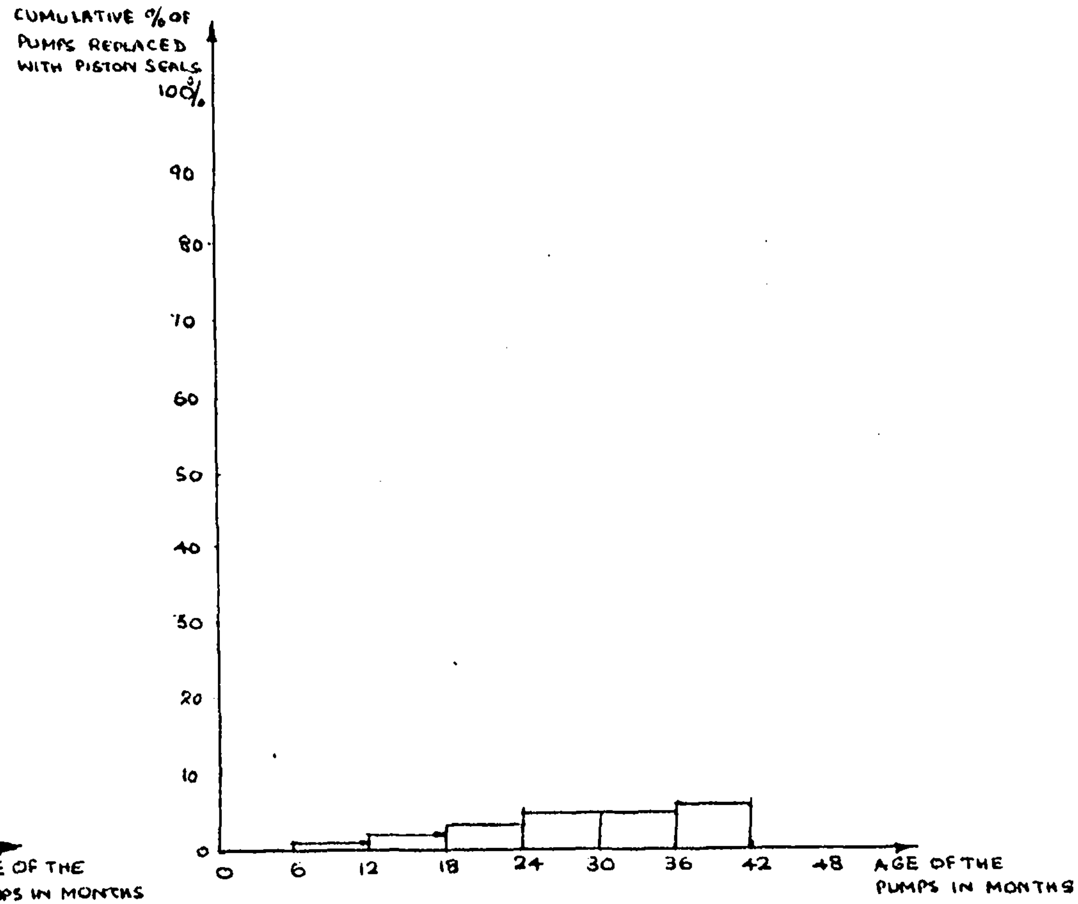


FIG. 12 SECOND PISTON SEAL REPLACEMENT IN MALDEV HANDPUMPS.

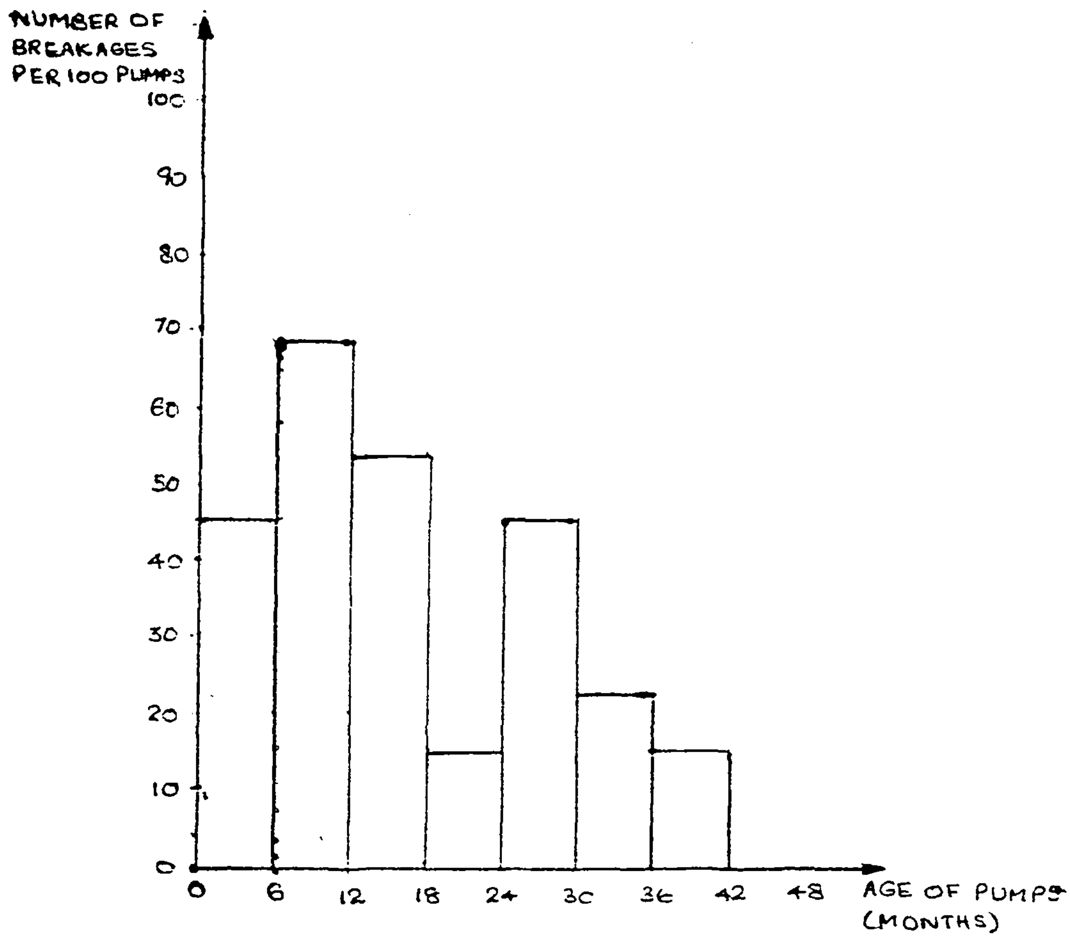


FIG. 13 NUMBER OF RISING MAIN BREAKAGES PER 100 CONSALLEN PUMPS.

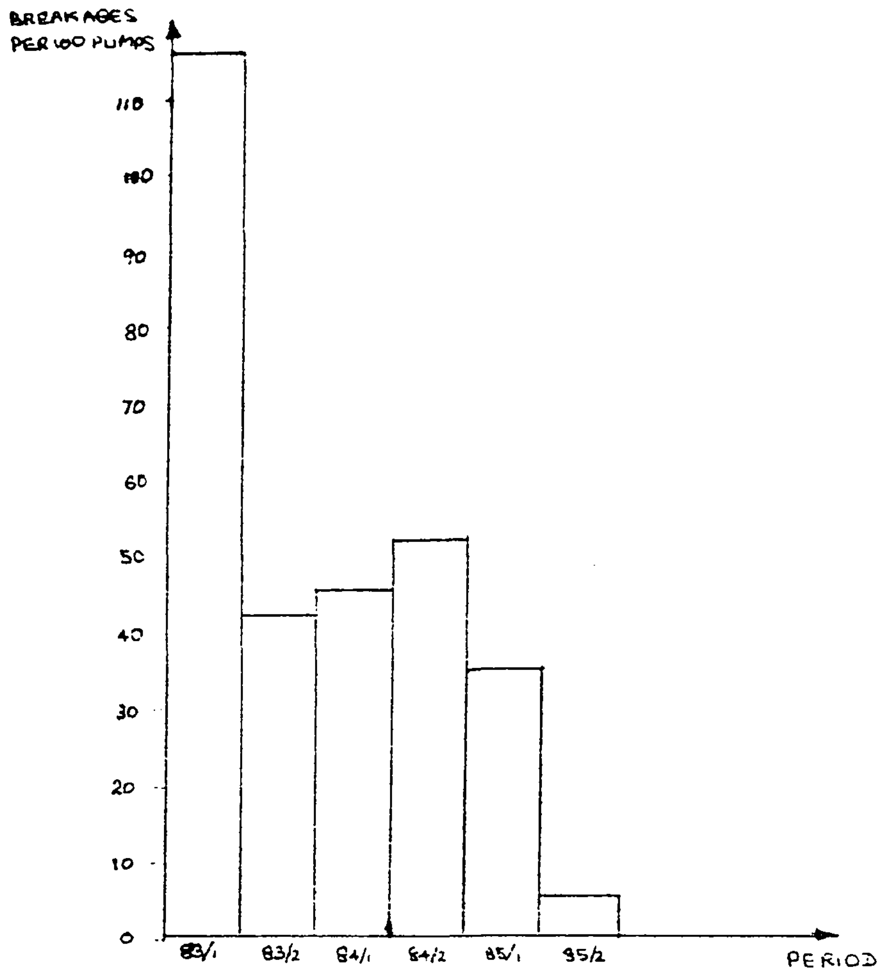


FIG. 14 PUMP ROD TO HANDLE CONNECTION FAILURES IN MK V PUMP.

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83/2 = NOV 83 - M

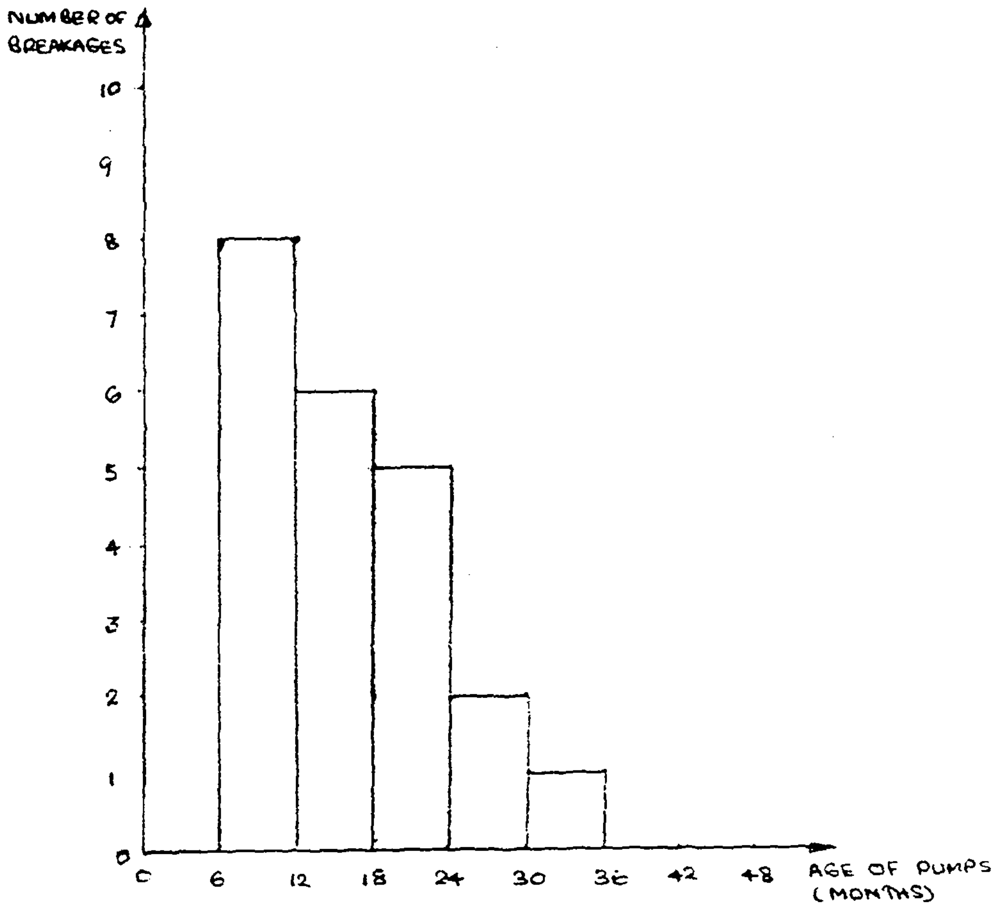
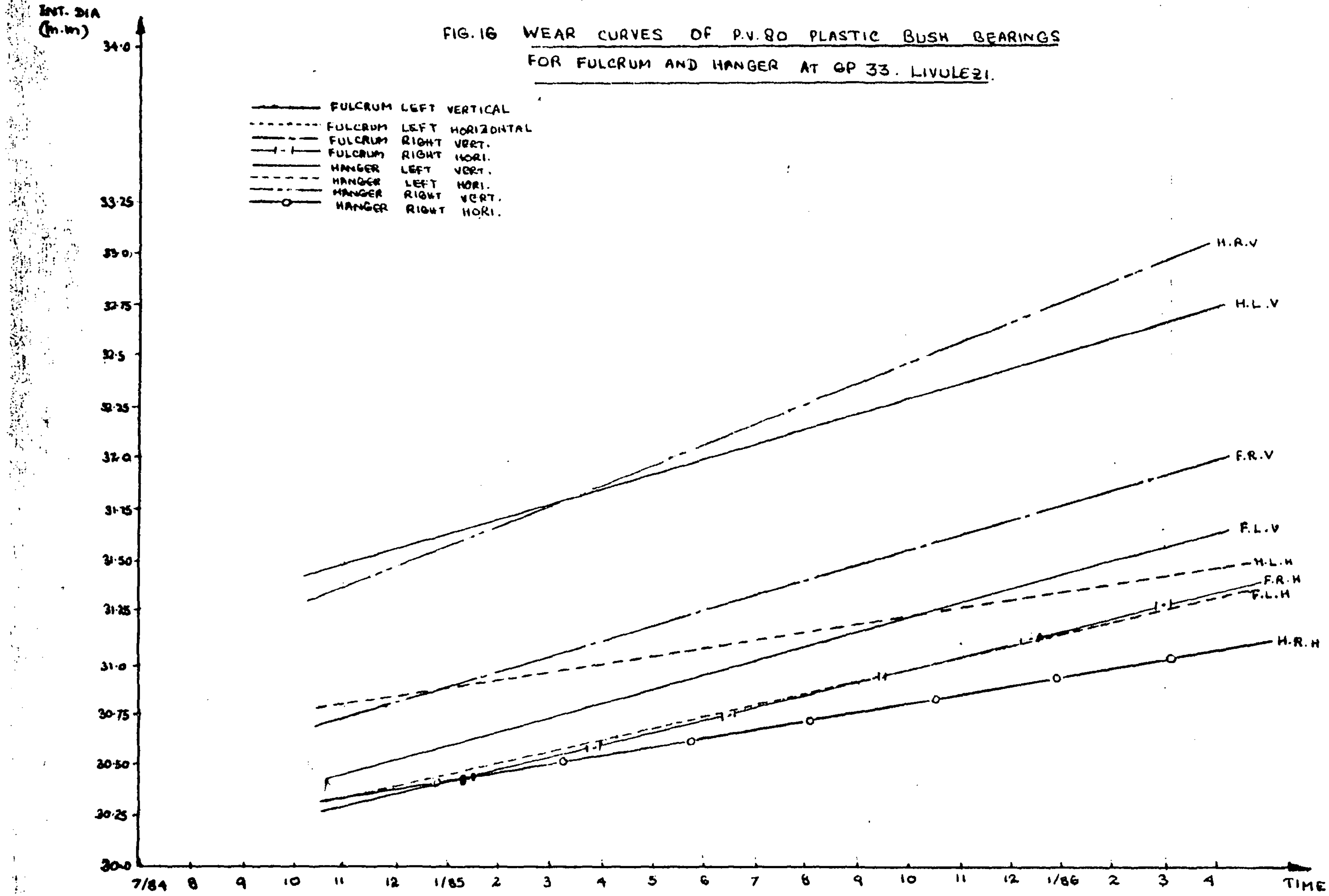


FIG. 15 TOP RISING MAIN TO HANDLE CONNECTION BREAKAGES IN 'MADZI BLAIR' PUMPS.

FIG. 16 WEAR CURVES OF P.V. 80 PLASTIC BUSH BEARINGS FOR FULCRUM AND HANGER AT GP 33. LIVULEZI.



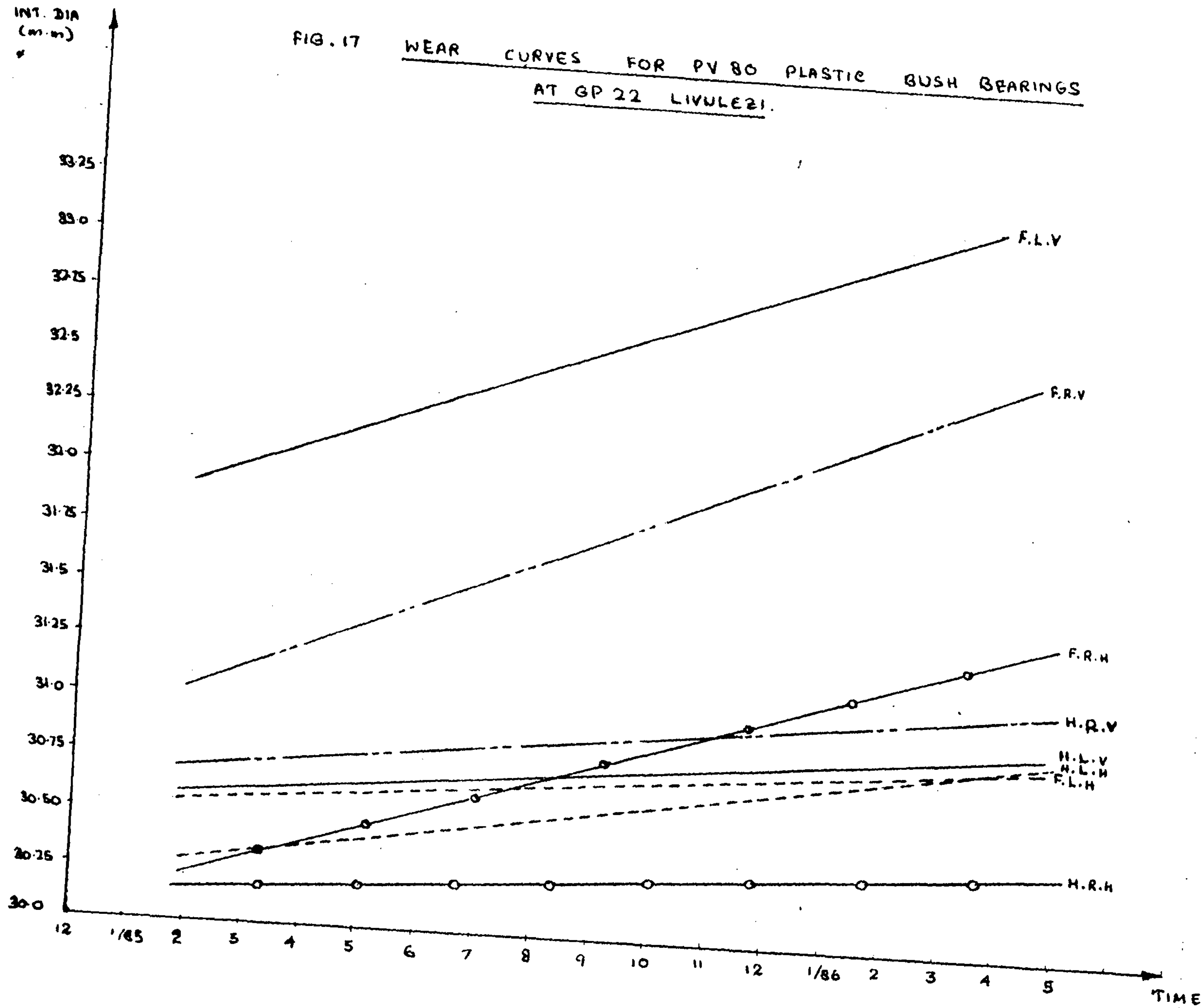


FIG. 17 WEAR CURVES FOR PV 80 PLASTIC BUSH BEARINGS AT GP 22 LIVULEZI.
INT. DIA (m.m)
33.25
33.0
32.75
32.5
32.25
32.0
31.75
31.5
31.25
31.0
30.75
30.50
30.25
30.0
12
1/85
2
3
4
5
6
7
8
9
10
11
12
1/86
2
3
4
5
TIME
F.L.V
F.R.V
F.R.H
H.R.V
H.L.V
H.L.H
F.L.H
H.R.H

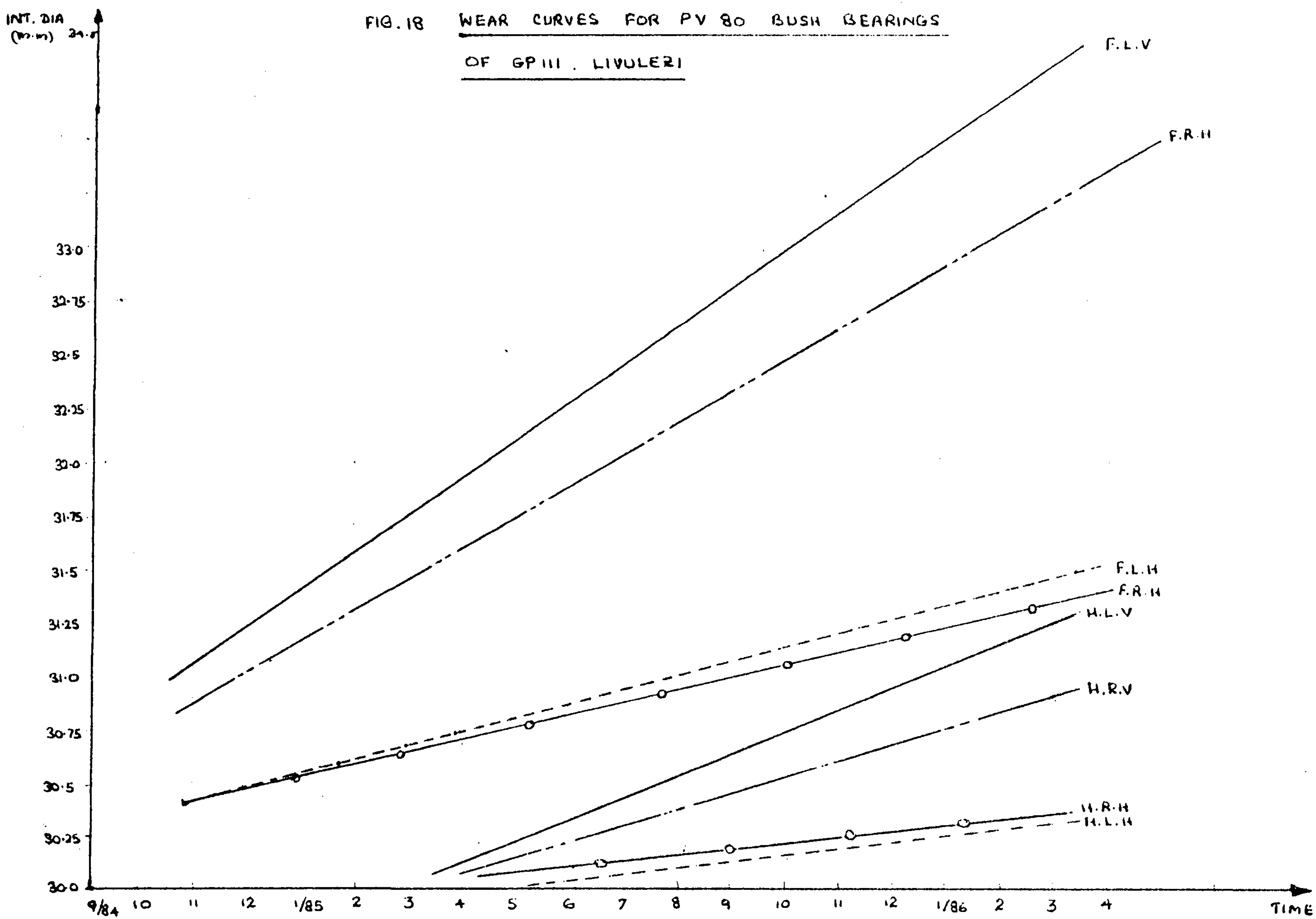


FIG. 18 WEAR CURVES FOR PV 80 BUSH BEARINGS OF GP III. LIVULEZI
INT. DIA (m.m)
34.0
33.0
32.75
32.5
32.25
32.0
31.75
31.5
31.25
31.0
30.75
30.5
30.25
30.0
9/84
10
11
12
1/85
2
3
4
5
6
7
8
9
10
11
12
1/86
2
3
4
TIME
F.L.V
F.R.H
F.L.H
F.R.H
H.L.V
H.R.V
H.R.H
H.L.H

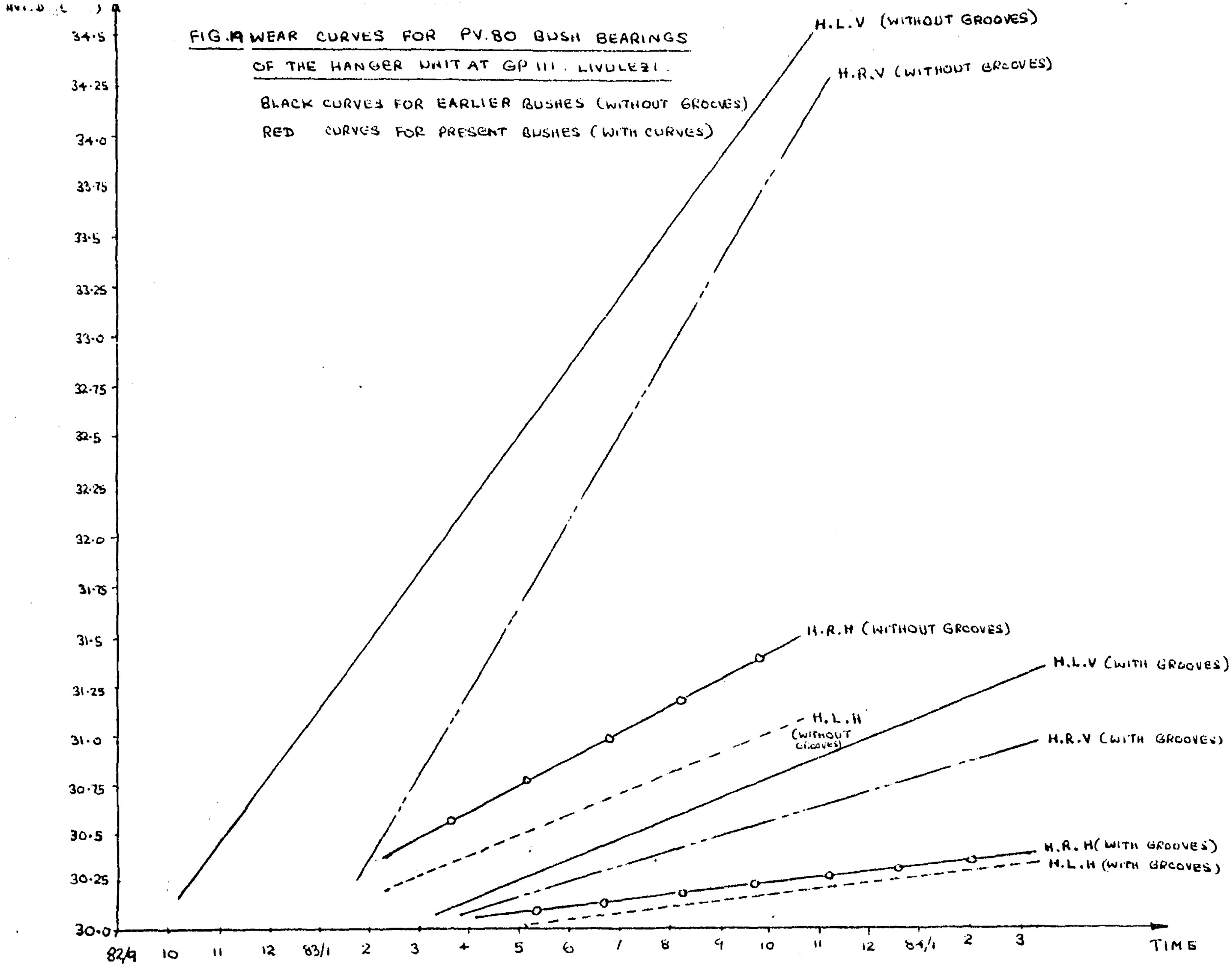


FIG. 19 WEAR CURVES FOR PV.80 BUSH BEARINGS
OF THE HANGER UNIT AT GP III. LIVULEZI.
BLACK CURVES FOR EARLIER BUSHES (WITHOUT GROOVES)
RED CURVES FOR PRESENT BUSHES (WITH CURVES)
H.L.V (WITHOUT GROOVES)
H.R.V (WITHOUT GROOVES)
H.R.H (WITHOUT GROOVES)
H.L.H (WITHOUT GROOVES)
H.L.V (WITH GROOVES)
H.R.V (WITH GROOVES)
H.R.H (WITH GROOVES)
H.L.H (WITH GROOVES)
34.5
34.25
34.0
33.75
33.5
33.25
33.0
32.75
32.5
32.25
32.0
31.75
31.5
31.25
31.0
30.75
30.5
30.25
30.0
82/9 10 11 12 83/1 2 3 4 5 6 7 8 9 10 11 12 84/1 2 3
TIME

PV. 80 PLASTIC BEARING MEASUREMENTS AT LIVULEZI

All Dimensions are in mm.

		NON ROTATING				ROTATING				NON ROTATING			
		GP 33				GP 111				GP 22			
		FULCRUM		HANGER		FULCRUM		HANGER		FULCRUM		HANGER	
DATE		L	R	L	R	L	R	L	R	L	R	L	R
14 11/84	V	30.8	30.8	31.5	31.4	30.9	30.8						
	H	30.5	30.4	30.4	30.5	30.5	30.4						
11 01/85	V	31.0	31.3	31.6	31.8								
	H	30.6	30.7	31.2	30.6								
08 02/85	V	30.7	31.1	31.7	31.1	32.0	31.7	NEW BUSHES (WITH GROOVES ON 15/3/85		31.0	31.1	30.6	30.6
	H	30.5	30.4	31.15	30.5	30.5	30.3			30.3	30.3	30.2	30.15
06 06/85	V	30.95	31.25	31.85	32.1	32.35	31.9	30.45	30.3	32.35	31.4	30.65	30.9
	H	30.75	30.75	31.10	30.5	31.25	30.85	30.0	30.1	30.80	30.5	30.50	30.2
30 10/85	V	31.25	31.5	32.6	32.0	32.85	31.95	30.75	30.55	32.60	31.9	30.75	30.85
	H	31.00	30.95	31.2	30.6	31.25	31.0	30.15	30.30	30.8	30.85	30.6	30.3
13 03/86	V	31.6	32.1	32.7	33.0	33.9	33.45	31.25	30.90	33.15	32.35	30.85	31.1
	H	31.3	31.7	30.9	31.3	31.35	31.35	30.40	30.25	30.8	31.35	30.75	30.3
								OLD BUSHES (WITHOUT GROOVES)					
14 10/83	V							30.2	30.2				
	H							30.2	30.2				
30 3/83	V							-	-				
	H							30.3	30.4				
27 4/83	V							-	-				
	H							30.4	30.6				
18 5/83	V							32.1	31.4				
	H							30.4	30.9				
22 6/83	V							32.8	32.0				
	H							30.6	31.1				
16 8/83	V							33.8	33.0				
	H							30.7	31.0				
20 10/83	V							34.4	34.6				
	H							31.1	30.6				