



INDIAN RAILWAYS

TRACK MACHINES DIGEST

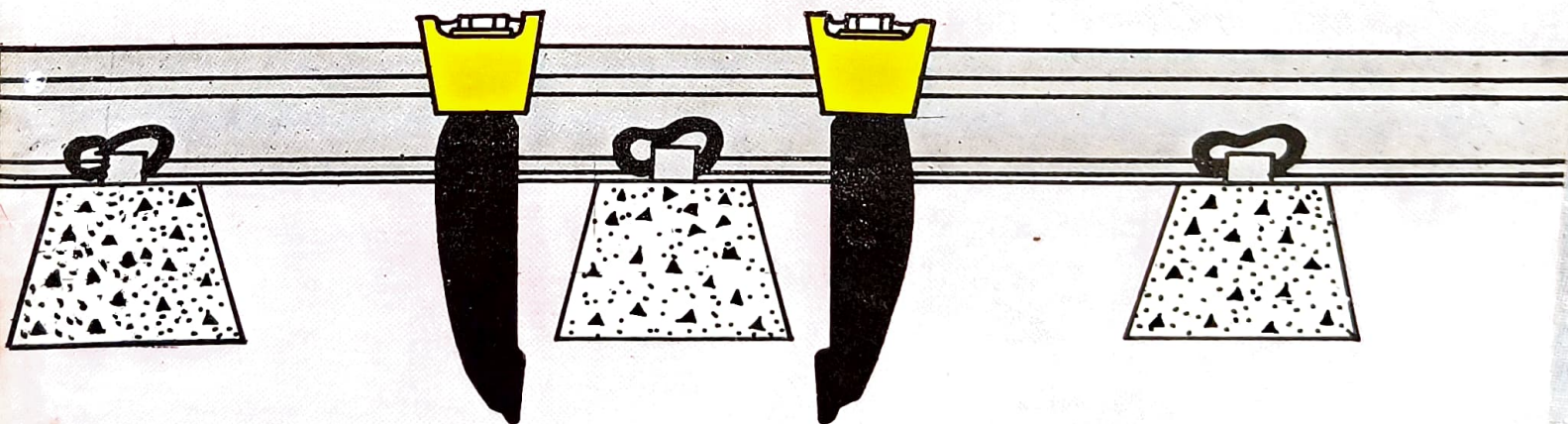
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INDIGENISATION OF PARTS OF LARGE TRACK MACHINES

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1. INTRODUCTION :

In last 3 decades, approx. 300 nos. of large track machines of various TYPES, MAKE & SERIES have been inducted into Indian Railways, Diversity of Make and series, rapidly changing technology, OEM's (Original Equipment Manufacturers) market policy regarding spares, non availability of design support from OEM, lack of manufacturing drawing and material specification, replacement of original spares details from the body of component by OEM's part no. etc. have forced us to buy imported spares at exorbitant cost through OEM only. In addition, non availability of such spares, even with the OEM affect down time of machines.

2. THRUST FOR INDIGENISATION :

In order to avoid import of spares and save hard currency, and to improve availability of reliable spares. Railways, RDSO and CPOH are doing significant works in the direction of indigenous development of spares. These efforts are not well coordinated and documented, hence there may be duplications.

2.1 AN EXPERT COMMITTEE appointed by the Railway Board submitted report on the optimisation of maintenance and operations of large track machines. It suggested that "import of certain important items may continue especially from the point of view of durability and reliability of spares. Import of high quality items, like 'o' rings, seals, hydraulic pump motors, valves fitting and electronic items, are required".

This is being followed more or less. Electronic components are now available to a large extent in the market. However quality of imported PCB is still superior.

Expert Committee also suggested that base for source development should be widened and multi-agencies should be encouraged. The CHOP Workshop/ALD, is working in this direction but reputed firms with ISO-9000 certification are not coming forward due to Railway's complex procurement system, inadequate quantity and uncertain quantum of business. Reputed firm like CUMMINS / PLASSER (INDIA) first search reliable and quality oriented satellite vendors and arrive at competitive rates on year to year basis. Two to three vendors are given one type of component. And they are having assured market with OEM, till they adhere supply schedule and quality at competitive rates. Since such working is not feasible in present setup. Track machine organisations have not been able to develop good satellite vendors.

2.2 RDSO/LKO was entrusted with indigenisation and other track machine development by setting up a separate Track machine & monitoring Directorate during the year 1992. RDSO has already issued drawing and material specification of 22 vital spares of large track machines. Details are placed at Annexure '5'.

2.3 CHOP/WORKSHOP ALLAHABAD is an Indian Railways organisation which does POH of all types of tamping machines (except UT machine), overhauling of tamping units and IOH of tamping machines of N.Rly. It has also developed a nos. of spares of large track machines in past 10 years.

3. OVER INDIAN RAILWAYS, SPARES ARE PRESENTLY ARRANGED THROUGH FOLLOWING SYSTEMS :

3.1 There are many imported spares, which are made available only by OEM or OEM's Authorised Dealers. These are PAC items (monopolistic market). These are quite costly. There is need to develop such items. For example a few items are shown in Annexure '1' PAC items. Presently one ZF (Hydodynamic) gear box is costing Rs. 60 Lakh. The cost may come down below Rs. 20-15 Lack if developed by Indian Manufacturer. There are 100 such ZF gear box in use over Indian Railways. More than 5 years old ZF gears have started giving trouble. Spares are needed for repair/replacement. Thus ZF gear box alone offers great deal of market for Indian Manufacturers. There are many more mechanical. Electronics, pneumatic, hydraulic components which requires indigenisation. The interested firms asked for at CHOP/Allahabad for this purpose.

3.2 Second type of spare are also imported spares which have been decoded after consulting various catalogues and these are made available at competitive cost. It is constantly tried to make use of present liberalisation on import of items. This effort has been able to break the PAC and OEM's monopoly. Efforts of some staff of CPOH/Allahabad are highly appreciable in this direction. Details of such spares are given in Annexure-2. This forms part of indigenisation in the sense that such quality products are not being manufactured by Indian firms. And previously these items were not available in Indian market. But now costly Hydraulic pump, motors, valves, Bearings are available in Indian market

through their Authorised representatives. As a result, a large nos. of item have been removed from the lists of PAC items. And cost of spares have reduced drastically. For example, previously we used to purchase servo valve at the cost of Rs. 2.0 Lack each. Presently it has reduced to Rs. 70,000/- each. Similarly, cost of imported seals have come down by 300-100%. This has been possible only after deep study & understanding of catalogue by the dedicated officers & supervisors of track machine organisation.

3.3 Equivalent Indian spares which are already available in Indian Market :- Such spares have been developed by giving samples, discussing specifications / design details with firm's technical representative, studying catalogue of various Indian products for example Hydraulic and Pneumatic valves - Rexroth, Vickers, Denison & Schrader makes, filters / Accumulators of EPE Make. Compressor of Elgi, Hydraulic pump / motor of Denison, etc. Details of such spares is given in Annexure '3'. Pneumatic components fitted by OEM's are quite costly. These are not readily available Recently we modified mechanical pneumatic system of CSM-913 CRLY with their help. The use of Schrader parts which are readily available at cheaper cost. Savings per machine may of the order of Rs. 2.5 lack.

3.4 Mechanical components which been developed through local vendors of LKO/NDLS/ALD.

We adopted principle of REVERSE ENGINEERING. Released / new samples (imported components) were given to local manufacturing workshop. Physical & chemical prop-

erties of components viz shape, size, tolerance, hardness, grinding surface finish, forged / cold drawn / rolled, seamless, material composition etc. were analysed. Experience and job requirements further decided the final product. In the beginning, we went quite slow and waited for performance testing which was done on the machine itself. Intentionally, we did not intimate Railways that "developmental" items have been installed on their machine. We simply observed failure reports of that units and assessed performance. This was compulsion for want of well established R&D workshop.

Approx 500 spares of large track machines have been developed so far. For example, a few spares are shown at Annexure '4'. All components of Tamping units, Gears and a few components of main Gear box, six speed & reversing gear box, Crown & Tail pinion of Axle assemblies, wheel measuring trolley, wheel, Hydraulic / Pneumatic cylinders, cardan shafts of UT/DUO/UNO PB bush and a no. of other items have been developed. We are presently working on ZF (Hydrodynamic) gears, PCBs and other costly items. One set of indigenised Tamping unit itself save approx. Rs. 80-90 Lack.

4. STRENGTH / WEAKNESS AND PROBLEMS :

4.1 The development of indigenous spares can be readily made available. The job of developing mechanical / Hydraulic components is on the basis of released / oil components, hence difficult to duplicate the items with perfection.

4.2 Process of this development is quite slow due to lack of schedule of powers vested with CPOH for this activity. We have to resort to short cut methods as direct purchasing power is limited to Rs. 250/- per item for such developmental works. Joint purchasing committee of 3 officers should be made and should be authorised to directly place order / purchase. Substantial imprest should be given to this committee. They should be allowed to do market survey and purchase the items directly for testing, assessment and development.

Also new/original spares should be kept as sample so that each time comparison can be made.

4.3 In absence of design parameters particularly for electrical / electronic items, not much success in these two fields.

4.4 In Global machine contracts there is need to incorporate clause like "Origin of spares, make, part no., (Technical data) specific details of design parameter where ever applicable, manufacturing/material specification, drawing etc. shall be made available by the suppliers.

5. **CONCLUSION :** There has been a definite progress in the field of indigenisation of spares of large track machines. The progress can be made faster and fruitful by arming CPOH officers with adequate financial powers, RDSO & CPOH are presently not able to march ahead rapidly because of non-availability of new and original spares. Possibly same could be arranged right at the time of purchase of machines. Sources of spares, make, complete details should be made available to Railways.

IMPORTED (PAC) ITEMS.

SL NO.	DESCRIPTION OF COMPONENTS	PLASSER'S PART NO.
01.	MAIN GEAR BOX HOUSING WITH COVER	2E.71.01/2E.71.02.RT
02.	BRAKE VALVE (CSM)	90364
03.	GEAR FOR ZF GEAR BOX (6 SPEED)	AK 6-80
04.	REDUCTION GEAR BOX CSM/UNIMAT	EM 1045 MRI
05.	SATELLITE AXLE GEAR BOX HOUSING	UD.63.1001
06.	CARDEN SHAFT CSM	KGW.150.1000.110.00
	CARDEN SHAFT CSM	LZ420.LASO/VD72.2719
	CARDEN SHAFT CSM	KGW.150.0950.110.00
	CARDEN SHAFT CSM	KGW.150.1250.110.00
	CARDEN SHAFT CSM	LZ325L A 35/0112131
	CARDEN SHAFT CSM	KGW.180.0950.110.50
07.	HYDRAULIC CYLINDER OF 09 CSM / UNIMAT	40 TYPES
08.	TRANSDUCER : T/U DEPTH CONTROL	ELT.920.0012
	LINING CONTROL	ELT.609.00
	X-LEVEL	UC.252III
09.	ANTI VIBRATION MOPUNTING PADS	5018053-11MN55
10.	HYDODYNAMIC ZF GEAR BOX COMPLETE	4WG65WKII
11.	DISTRIBUTOR GEAR BOX	UD.64.900

ANNEXURE 'II'

IMPORTED (NON PAC) SPARES

SL NO.	DESCRIPTION OF ITEM	PLASSER PART NO.	EQUIVALENT PART NO.
1.	PROPORTIONAL VALVE COMPLETE	HY-10-RSE-A	REXROTH PART NO. 4RZ.25.1E.325-30/6a-NET-A-D3M
2.	HYDRAULIC VARIATION DELIVERY AXIAL PISTON PUMP.	HY-704X90L/EL-210-BAR	REXROTH PART NO. A4V901E1-OLOO1-A35
3.	HYDRAULIC MOTOR FOR SATELLITE DRIVE	HY-916-500	DANFOSS PART NO. OMV-50 (WITH SPLIN SHART)
4.	CYLINDRICAL ROLLER BEARING.	0635-421-276	NUP-314ENMC3(TO USE WITH OUT 'P')
5.	CYLINDRICAL ROLLER BEARING.	0635-421-254	NUP-314ENMC3(TO USE WITH 'P')
6.	CYLINDRICAL ROLLER BEARING	U-20-217	NJ-219MC4(KOYO)
7.	TAPER ROLLER BEARING	DL-63-307	32032X
8.	TAPER ROLLER BEARING	0635-501-408	K-29590-29521(LN)
9.	TAPER ROLLER BEARING	0635-501-400	K-33889-3382221 /22 (LN)
10.	TAPER ROLLER BEARING	0635-501-338	K-33885-33822-21 /22 (LN)
11.	ACCUMULATORS 30/22L	HY.156.09	HYDOC SB210.HF.30-32-32A1 / 112-1-1
12.	ZF HYDRODYNAMIC	NA	4WG-65-WK-II
13.	ZF 6 SPEED GEAR BOX	NA	AK-6-80

EQUIVALENT SPARES (INDIGENOUS)

ANNEXURE '3'

SL NO.	DESCRIPTION OF ITEM	PLASSER PART NO.	EQUIVALENT PART NO.
1.	SOLENOID OPERATED D.C. 4 WAY VALVE	HY-10-RSE-A	REXROTH NO. 4WE-10-R-3.1/G24-NJ4L
2.	HYDRAULIC UNLOADER VALVE	HY-IN-250BHY-IN-20-50B	VICKERS PART NO. URG-1-10-F-12
3.	CYLINDRICAL ROLLER BEARING	UD-62-2610-P	NJ-224MC4
4.	MASTER CYLINDER FOR DUO		GIRILING PART NO. 84574202
5.	SLAVE SERVO FOR DUO		TVS. PART NO. M200340
6.	EE BRAKE VALVE WITH PADAL FOR DUO.		TVS. PART NO. M830260
7.	TC2 VALVE	UD-62-2610-P	TVS PART NO. P1003139
8.	AIR UNLOADER VALVE	HY-IN-20-50BHY-IN-20-50B	TVS PART NO. 301040
9.	SHUT OFF-COCK	0635-421-254	TVS PART NO. P10000531/M800210
10.	SOLENOID OPT. 3 WAY 1/2" NO.2		SCHRADER PART NO.3461G1/2
11.	PNEUMATIC 4 WAY VALVE HAND-LEVER		SCHRADER PART NO.530041./R
12.	1/4" QUICK RELEASE VALVE	90252	SCHRADER PART NO.G-1/4 (3640)
13.	1/3" AIR PRESSURE REGULATOR WITH GAUGE.	90183	SCHRADER PART NO.G-34646
14.	1/4" SINGLE SOLENOID VALVE-24 VDC COIL.	90339	SCHRADER PART NO.G-53014
15.	DOUBLE SOLENOID SELF CONTR-ACTING VALVE 24V DC COIL.	90341	SCHRADER PART NO.G-53024

ANNEXURE '4'

MECHANICAL COMPONENTS OF DEVELOPED

SL NO.	DESCRIPTION	PLASSER PART NO.
1.	TAMPING UNIT-DUO. /CSM	GROUP-UD-141E
2.	CROWN OF GEAR WITH SHAFT DUO /UNO	UD70.03,UD70.04,UD75.33 &UD-75-06
3.	TRAIN OF GEAR-DUO. /UNO	2E.71.04,G70.07B, 70.94
4.	LIFTING & LINING UNIT DUO/CSM	UD.150,900
5.	WHEELS & AXLE (DRIVING) COMPLETE ASSLY. DUO.	UD61.650/UD61,3500.0D.4100 (EXCEPT FRAME)
6.	WHEELS & AXLE (DRIVING) COMPLETE ASSLY. CSM.	
7.	SATELLITE GEAR PINION SHAFT (CSM)	UD64-1302,UD64.1303,UD63.1264.
8.	WHEELS & AXLE (RUNNING) COMPLETE ASSY. (DUO)	UD-62-900

SL NO.	DESCRIPTION	PLASSER PART NO.
9.	WHEELS & AXLE (RUNNING) COMPLETE ASSY (CSM).	PB-61-300 (EXCEPT FRAME)
10.	POWER TAKE OFF ASSY (DUO/UNO)	N70/16
11.	REVERSING GEAR ASSY. (DUO/UNO)	UD-75-900-1935 (1250-298-917)
12.	LAY SHAFT AND GEAR SET FOR SIX SPEED GEAR BOX OF DOUMATIC.	1250.203.002
13.	CLUTCH BODY, SLIDING, SLEEVE, CARRIER AND INTERMEDIATE SHAFT FOR REVERSING GEAR BOX OF DUOMATIC	1240.304.343 1250.312.204 1250.312.203 1250.312.130
14.	HOUSING OF CLUTCH ARRANGEMENT	180106520018
15.	SWIVEL BEARING TYNE HOLDER & TAMPING ARM (UNI)	W.37.130120 CU.37.603 W.37.1702
16.	DOUBLE GEAR & HELICAL GEAR (DUO)	1250.303.056, 1250.303.111 1250.303.058
17.	FLY WHEEL & CLUTH HOUSING	DL.72.01 DL.72.02

ANNESURE- '5'

R.D.S.O. ITEMS

SL NO.	SUBJECT	SPECIFICATION	DRAWING NO.
	<u>TIE TIMPING MACHINE :</u>		
1.	TAMPING TOOL FOR CSM	TM/HM/6/26	TM/9303
2.	TAMPING TOOL FOR UNIMAT	TM/HM/6/26	TM/9327/A
3.	GEAR WHEEL (SATELLITE GEAR BOX FOR CSM	TM/HM/6/21	TM/9614
4.	PINION (STELLITE GEAR BOX) FOR CSM	TM/HM/6/21	TM/9615
5.	FLIFTING-CUM-LINING ROLLER DISC FOR TAMPING MACHINE.	TM/HM/6/21	TM/9322
	<u>BALLAST CLEANING MACHINE:</u>		
6.	SCRAPER SHOVEL, INTERMEDIATE LINK ROUND SHAFT CHISEL, CHAIN BOLT ETC. FOR RM-80	TM/HM/6/8 TM/9302(REV)/B	TM/9302(REV)/A
	<u>MISCELLANEOUS :</u>		
7.	SCRAPER LINK, INTERMEDIATE LINK, BOLT ROLLER SLEEVE & BUSH OF SHOULDER BLLAST CLEANER.	TM/HM/6/6146	TM/9422/1
8.	WEAR PLATES OF BCM RM-80 PART NOS. 62-08-1215,64-08-1369,62-08-1449,64-08-1636.	TM/HM/6/15	TM/9315/1
9.	WEAR PLATE OF BCM RM-80 PART NOS. 64-08-1461,62-08-1217,62-08-1300,64-081623	TM/HM/6/15	TM/9315/2
10.	N.T. RUBBER PAD FOR TRT MODEL P-811S	TM/HM/6/146	TM/9606

RUBBER AND RUBBER COMPOUNDS

- 1) Ingredients of Rubber Compound.
- 2) Various Tests carried out on Rubber Compound and Rubber Products.
- 3) Information required for a Rubber Technologist for Designing a Rubber Compound.
- 4) Introduction of the Terminology used in Rubber Industry and ASTM Classification of Rubbers according to their Service, Temperature Range.

1. INGREDIENTS OF RUBBER

COMPOUND:

- 1) Rubber-Polymer/Elastomer
- 2) Peptizer
- 3) Age resistor-
(Antioxidant & Antiozonants)
- 4) Activator
- 5) Fillers
- 6) Plasticizer & Oils
- 7) Accelerator
- 8) Curative
- 9) Special Additives

1. RUBBER: It can be classified into two broad groups, Natural and Synthetic.

NATURAL RUBBER : Manufactured from Rubber Tree. Based on method of manufacture,

it is graded as followed.

Liquid Latex : Collected from tree, preserved chemically and used for products which are made by dipping method, example Toy Balloon, Surgical Gloves, Prophylectics, Latex Tubes Threads

Solid Rubber : These are grouped into two, based on methods of manufacture and purity. PLC - Pale Crepe- Lighter in colour. High Rubber Contents. Widely used for coloured rubber articles.

RMA - Dark in colour - Dirt content more than PLC.

Both grades have further sub-grades 1 X, 1,2,3,4,5, depending on quality of latex from which it is manufactured.

SYNTHETIC RUBBER : The word itself indicates that these rubbers are made by chemical reactions between two rubbers. Technical word for chemicals in "MONOMER"

Most of these Monomers are derived from C4 Petroleum Fraction, example Butadiene. Isoprene Isobutylene. These Monomers under Polymerisation process. The properties of Polymers are controlled with close Tolerances, such as Volatile Matter, Mooney Viscosity, Colour, Specific Gravity, Relative Ratio of two Monomers.

Among these synthetics we can conveniently them into two groups :

GENERAL PURPOSE SYNTHETIC RUBBER:

Styrene-Butadiene (SBR), Acrylonitrile Butadiene (NBR), Polychloroprene (CR)

SPECIAL PURPOSE SYNTHETIC RUBBER :

Silicone, CSM (Hypalon) Fluorocarbon (Viton), Polyacrylic.

SILICONE : Needs a special mention here, as it is not derived from C4 fraction but from sand. It is called Inorganic Rubber as it does not contain Elements Carbon-Hydrogen. These are commonly used Speciality Rubbers in the Industry.

PEPTIZER : All the rubbers are High Molecular Weight Polymers and very difficult to process as it is in order to reduce this Molecular Weight "Peptizer" is added which reacts Chemically with Rubber and helps to reduce mixing energy and mastication time.

AGE RESISTOR : They are called as Antioxidants and Antiozonants. Whatever properties of Rubber are obtained these need to be protected from effects of heat, ozone and other environmental factors. In order to give such protection these chemicals are used. Antioxidants give protection against heat especially during service condition of product. Antiozonant are special in the sense that they prevent attack of ozone on rubber. Ozone attack on rubber can cause fast degradation and cracking of rubber surface. Both these chemicals are manufactured

by well known chemical companies like M/S. Bayer (India) Ltd., M/S. Polyolefin Industries Ltd., and M/S ICI (India) Ltd.

ACTIVATOR : These are Metallic Oxides such as Zinc Oxides, Magnesium Oxides, which form active complexes with Accelerator at Vulcanisation Temperature and thereby facilitate reaction of Vulcanisation i.e. Cross Linking.

FILLERS : This is another essential ingredient of any Rubber Compound. Rubber as such or Pure Gum of little use unless it has adequate combination of Hardness, Tensile and Elongation. In order to achieve these properties, Fillers are used. Two major groups are considered Black and Non-Black Fillers. Carbon Black is largest consumed Filler in all technical products example Tyres. Oil Seals, Hoses and various automobile components. There are about five main grades and each grade is having further sub-grades. Choice of grade depends on nature of product, process involved in manufacturing the product and desired properties such as Hardness, Tensile Strength, Elongation. Among Non-Black Fillers, mostly Mineral Fillers are used. Precipitated Fumes Silica is widely used when one has to design Non-Black Compound with good physical properties. It gives properties which can be obtained by Carbon. Hence it is also called as White Carbon. Other Non-Black Fillers consti-

tute various types of Clays, Soft Caly, Hard Clay, Calcined Clay, Barytes, Silicates, Whiting, Precipitated Calcium Carbonate etc.

PLASTICIZER : Elastic properties of Rubber are advantageous in Vulcanised product but they make it difficult to process the Rubber during Mixing, Extrusion & Calendering.

It is necessary to reduce this Elasticity temporarily & it is achieved by use of Softeners & Plasticizers. They also help to control temperature during mixing of Compound, also help for easy incorporation of Filler & reduction in Power Consumption. Among Plasticizers Petroleum based Oils are widely used for general purpose products. Petroleum Oils are broadly grouped in Paraffinic, Nopthenic and Aromatic depending on the relative composition.

Synthetic Rubbers need special type of Plasticizer, example Nitrile Rubber required Ester type of Plasticizer.

Compatibility of Plasticizer with Polymer is a key factor in selecting these Plasticizer.

ACCELERATORS : These are groups of complex organic Chemicals which speed up cross linking reaction or Vulcanisation. Accelerators reduce time and temperatures required to cure rubber, they are classified as Medium, Fast, Ultra Fast, Delayed Action depending on their speed of the action.

Manufacturing process of a product and properties required in the final product govern the choice of Accelerators. Normally in order to achieve this always a combination of two/three Accelerators are used. These chemicals are also manufactured by Bayer, PIL and ICI.

CURATIVES : Sulphur is dominant curing agent used in most of the Rubbers. Peroxides are used when Sulphur cured article is not acceptable due to the presence of free sulphur in Rubber. Speciality Elastomer such as Polyacrylic Viton, Hypalon need their specific curatives. Sulphur may not be suitable for them.

SPECIAL ADDITIVE :

BLOWING AGENT : To prepare sponge type of rubber articles these are used. Example Hawaii Sponge Profiles and Foams.

FERRITE : It is used for making Magnetic Rubber Products, Article is magnetised after Vulcanisation, example Fridge Door Gasket.

COLOURS : For coloured rubber articles there are again special grade colours which retain their original shade at Vulcanisation Temperature i.e. 160°C.

ABRASIVE : Glass Powder, Pumice Powder. Their abrasive property is utilised in pencil Ink and various other types of Erasers.

ANTI-STATIC AGENT : It is used to avoid build up of static charges on Rubber. It makes the Rubber articles anti-static. All rubber articles

in operation theatre, airport, underground mining industries etc. needs to have anti-static properties.

This completes the list of ingredients in a Rubber Compound, it also indicates the difficult task a Rubber Technologist has to face while making his choice. Rubber compounding is one of the most difficult of complexes. It is partly a science and partly an art and one has to cope up with literally hundreds of variables in materials and machines.

MIXING OF RUBBER COMPOUND **& VULCANISATION**

OPEN MIXING MILL : Very common and easiest method. Used in Industry. Two rolls are revolving towards each other and move at different speeds. This creates a friction ratio between two rolls which generates shear forces on rubber. Due to this chemicals and fillers get mixed in rubber. It is the physical mixing that takes place during this process.

BANBURY/INTERNAL MIXER : These are closed chamber machines. The chamber encloses two rotors with wings, again moving at differential speed. The difference in rotor design distinguishes on machine form the other.

Advantage of this machine is very fast mixing and good dispersion in a short time. Approximately three times more output is obtained as compared with open Mill Mixing.

Other equipment required for processing the rubber are :

1) **EXTRUDER :** For extruded article, Profile / Tube /Hose.

2) **CALENDAR :** For all types of rubber sheet and Rubberised Fabric. Rubber is processed on these machines and then vulcanised in a suitable way.

DEFERENT METHODS OF VUCANISATION

HOT AIR Here article is indirectly heated by steam and pressure is achieved by compressed air.

HYDRAULIC PRESS : All moulded products such as Oil Seals, "O" Rings, Mats. Automobile Parts are made by moulding in a press.

OPEN STEAM CURE : This method is used for Hoses / Profiles. It is called Open Steam because here steam comes in direct contact with the product. Among the advanced techniques microwave curing is used. Mainly it is used for Profiles.

2. TESTS CONDUCTED ON RUBBERS:

When Compound is mixed it should be assured that each ingredient added is dispersed uniformly. In order to check this many tests have been developed. Some tests are carried out on Un-Vulcanised Compound and some on Vulcanised Compound.

MOONEY VISCOSITY : This test is carried in an instrument called Mooney Viscometer. It consists of two electrically heated platens which enclose a small cavity. A rotor is placed in this cavity, this rotor creates shear force on rubber which is measured in terms of Mooney Units.

Mooney Units are measured at 100°C/125°C. This gives an idea about processability of Compound. Scorch Time can also be measured in this instrument.

RHEOMETER : This instrument is same as Mooney Viscometer, it differs in speed and shape of rotor. The rotor oscillates instead of rotating in a single direction. Rheometer gives more information about the Compound, such as Scorch Time, Optimum cure time, rate of cure etc.

When a new compound is developed a Rheograph is run which gives a characteristic curve of that compound. When further batches are mixed they should give same curves so much so that they essentially super impose upon each other. Slight deviation from the original curve indicates changes in mixing cycle doses of Chemicals etc. Such differences can be corrected immediately. With the help of this Instrument it is possible to decide acceptability of Compound within a short time. Otherwise a tedious method measuring Tensile Strength, Elongation at Break is required and it takes anything between 12 to 24 hours.

TESTS CARRIED ON VULCANISED RUBBER

SHORE HARDNESS : This test is done by an instrument called Durometer. There are various models such as Hand, Held, Stand Type are available. Hardness is indicated as Shore "A"

TENSILE STRENGTH & ELONGATION AT BREAK :

These properties are measured on standard test pieces. A test slab is moulded of size 150 mm into 2 mm. Dumbel shaped test pieces are cut from the slab. a benchmark of 25.4 mm (1") is made on test piece and strength required to break the dumbel is measured on tensile testing machine. Tensile strength is calculated on original cross-sectional area by the following formula.

$$T.S. = \frac{\text{Breaking Load in Kgs}}{\text{Cross Sectional Area}}$$

It is expressed in Mpa or MN/m.sq. or kgf / cm. sq. or PSI. Elongation at Break is also measured using a suitable scale and expressed as a percentage of initial length.

These two properties give idea about consistency of mixing and batch variation. Major deviation from standard figures indicate that batch is not properly mixed.

ACCELERATED AGEING : In these tests standard dumbel test pieces are aged for specific duration and at particular temperature in an oven. After ageing is complete tensile strength and

elongation at break is measured and compared with initial properties.

The drop in the properties gives the idea about the life of Compound. This test is carried out in order to judge effects of environment, service condition in a short time span. Hence it is called Accelerated Ageing.

Commonly used Conditions of Ageing Tests -

1. Accelerated Hot Air Ageing :

70 hrs/70 deg. C

618hrs/70deg. C

70hrs/100deg. C

70hrs/120deg. C

2. Accelerated Oil Ageing : Test conditions are same as in (1).

Following standard oils are used in Testing.

- ASTM Oil No. 1

- ASTM Oil No. 2

- ASTM Oil No. 3

3. Fuel Ageing : This test is carried out at ambient temperature.

Following reference fuels are used.

ASTM Reference Fuel A - 100% Isooctane

ASTM Reference Fuel B - 70% Isooctane + 30% Toulene

ASTM Reference Fuel C - 50% Isooctane + 50% Toulene

ASTM Reference Fuel D - 40% Isooctane + 60% Toulene

There are some other teste carried out to judge behaviour of Rubber Compound under service condition or enviornmental condition.

1. Flexing Test : A standard test piece is flexed

through 180 deg. rapidly and number of cycles required to initiate a crack in the test piece are measured. This test gives idea about flexing resistance of Rubber Compound. This test is knows as Demattia Flex Test. Ross Flex Test. differs from it only in one aspect i.e. test piece is bent through 90 deg. C instead of deg. C These tests are conducted on Tyre Compound and Footwear Compound.

2. Abrasion Test : Here standard test piece is mechanically abraded under controlled condition and resistance to abrasion is measured in terms of weight loss and volume loss.

3. Ozone Test : This test is carried out in a specially designed Ozone Chamber Ozone concentration temperature and humidity is controlled during the test. Commonly used Ozone concentration are 25 + /-5, 50 + /-5, 40 + /-5 ppm.

Temperature is maintained 30 deg., 40 deg. or 50 deg. as specified. Test pieces are kept under tension for a specific period.

After the test is completed surface of test piece is observed for the cracks under Magnification from 5 to 10X. This test gives the idea of resistance of Rubber Compound to the Ozone attack. Resistance to Ozone is dependent on Nature of Polymer and Compound used.

4. Compression Set Test : This test consists of subjecting a test piece to compressive forces for specified period and temperature. At the end

of test the deformation is measured and expressed as percentage set. This test is useful for articles which are always under compression, example, Bridge Bearing Pad, Oil Seal.

5. Low Temperature Test : When Elastomers are exposed to sub-zero temperatures they become hard and in such cases if bend they crack, this happens because of loss in Elasticity. This behaviour is reversible and dependent only on temperature. Hence called as Glass Transition. Resistance to low temperature exposure depends on type of Polymer and Nature of Compound. Normally used temperature for this test is -40 deg. C.

Flame Resistant Test :

This test is done in order to judge the Fire Resistance of Compound in the event of Fire. The test is normally conducted on product. Sample piece is exposed to a Flame of Burner for a short duration of 30 seconds. At the end of this period Burner is removed and behaviour of Rubber is judged whether it continues to burn and extinguishes immediately. A Flame Resistant Compound extinguishes immediately when Burner is removed. Special Flame Resistant Chemicals are added in order to achieve this property.

Electrical Tests :

Normally Rubbers are classified as Insulating Material. But they can be compounded in

such a way when ever static charges are built up they will be earthed immediately.

A Rubber Compound having Electrical Resistance between 0.05 to 1.00 Megaohm when tested at 500 Volts is called as Antistatic Compound (Ref. B.S. 2050). This test is normally done using 500 Volts megger. Two Electrodes are fixed on the article at a specified distance and resistance is measured. It is expressed as Megaohm/m.

3. INFORMATION REQUIRED BY A RUBBER COMPOUNDER IN ORDER TO DESIGN A GOOD COMPOUND

- 1) Nature and end use of product.
- 2) Service Condition -
 - a) Maximum Temperature to which product is exposed.
 - b) Whether this exposure is continuous or intermittent.
- 3) Types of Chemicals, Fluid in which the product comes in contact. Concentration of these Chemicals/Fluids and Temperature is also required.

If these details are given then formulating a good Rubber Compound becomes comparatively easier.

Following properties Rubber Compounder has to bear in mind while designing a New Compound.

- a) Physical properties desired such as Hardness, Tensile- Strength, Modulus.
- b) Resistance to Abrasion and Tear.

- c) Resistance to Fatigue.
- d) Resistance to degradative agents i.e. Heat, Flame, Light, Ozone, Atmospheric Exposure.
- e) Resistance to Low Temperature.
- f) Electrical Properties.
- g) Resistance to Gas permeability.

In addition to above the Compound designed should also meet processing requirements.

- 1) Easy of release from Mill/Calendar Mill and ease of mixing.
- 2) Extruding Properties/Dimensional Stability.
- 3) Bin Storage-how long Rubber can be stored i.e. Scorchy behaviour if any.

4. ASTM D 2000 SAE J 200 :

Classification System for Elastomeric Materials for Automotive Applications

The following is an abbreviated course on how to interpret a typical "Line call-out" or specification using the example outlined in the D 2000 publication. An example line call-out may

comprise the following letters and numbers:

2 BC 510 A 14 E 034

The first portion of the call-out is called the basic requirement. This consists of the 2BC510. The basic requirements may be interpreted as follows:

- 2 = Grade number. This defines the performance level for the suffix requirements.
- B = The material type. This defines the aging temperature requirements. B type materials are aged at 100 deg. C (212 deg. F).
- C = The material class. This determines the Oil Swell requirements. C class materials have a 120% maximum Volume Swell in ASTM No. 3 Oil.

5. = The target Hardness. 50+/-5 Shore A.

10. = The minimum Tensile strength. 1000 PSI. If the line call-out starts with the letter M (for metric), the Tensile is given in MPa. (Since 1000 PSI=7 MPa, the equivalent metric call-out is M2Bc507).

The letters and numbers following the basic requirements are called the suffix requirements. These are added only as needed to meet specific end-use requirements. For example, the A14E034 suffix requirements may be interpreted as follows.

A = Special Heat Resistance. -15% maximum Tensile change and -40% maximum Elongation change. Without the A14 suffix, the basic type materials are permitted +/-30% Tensile change and -50% Elongation change after Heat Aging.

1 = The test method for Heat Resistance. ASTM D573 for 70 hrs.

4 = The Test Temperature for Heat Resistance. 100 deg. C (212 deg. F).

ED = Fluid resistance (Oil and Lubricants). As the case for Heat Resistance, this suffix allows less change in properties after ASTM No. 3 Oil immersion than the basic C class material.

3 = The test method for Fluid Resistance. ASTM D 471 in No. 3 Oil for 70 hrs.

4 = The test Temperature for Heat Resistance. 100 deg. C (212 deg. F).

The following table show Polymers most commonly used to meet the type and class requirements of ASTM D 2000 / SAE J 200. The meaning of the suffix requirement letters is also below.

TYPE & CLASS POLYMER COMMONLY USED

AA	NR, IR, SBR, IIR, EPDM, BR
AK	T
BA	EPDM, High Temperature SBR, IIR
BC	CR
BE	CR
BF	NBR
BG	NBR, AU, EU
BK	NBR, T
CA	EPDM
CE	CSM
CH	NBR, ECO
DA	E PDM
DF	ACM (Low Temperature)
DH	ACM
FC	HQ (High Strength)
FE	MQ
FK	FVMQ
GE	MQ
HK	FKM

MEANING OF SUFFIX LETTER

A	Heat Resistance
B	Compression Set
C	Ozone or Weather Resistance
D	Compression-Deflection
EA	Fluid Resistance (Aqueous Fluids)
EF	Fluid Resistance (Fuels)
EO	Fluid Resistance (Oils & Lubes)
F	Low-Temperature Resistance
G	Tear Resistance
H	Flex Resistance
J	Abrasion Resistance
K	Adhesion
M	Flammability Resistance
N	Impact Resistance
P	Staining Resistance
R	Resilience
Z	Any special requirement, as jointly agreed to by and Customer.

APPENDIX - I

The following tables show the basic types and classes that have been established for the ASTM D 2000 /SAE J 200 Nomenclature System.

A
B
C
D
E
F
G
H
J

TYPE BY TEMPERATURE

70 deg.C (158 deg. F)
100 deg.C (212 deg. F)
125 deg.C (257 deg. F)
150 deg.C (302 deg. F)
175 deg.C (347 deg. F)
200 deg.C (392 deg. F)
225 deg.C (337 deg. F)
250 deg.C (382 deg. F)
275 deg.C (327 deg. F)

CLASS BY VOLUME SWELL

A	No. Requirement
B	140% maximum
C	120% maximum
D	100% maximum
E	80% maximum
F	60% maximum
G	40% maximum
H	30% maximum
J	20% maximum
K	10% maximum

APPENDIX - II

INTERNATIONAL ABBREVIATION	COMMON NAME	CHEMICAL COMPOSITION	BRAND NAME	MANUFACTURER	PROPERTIES
SBR	SBR	Styrene Butadiene	Euoprene Duradene Synaprene Chemicals	Enchichem Firestone Synthetics & to Oil	Good Physical Properties. Heat Resistance better than NR poor Resistance
NBR	Nitrile Rubber	Acrylonitrile Butadiene	Perbunan Nipol Chemigum Aparene	Bayer Nipol Zeon Good year Gujarat Apar	Excellent resistant to Petroleum based Fluids and Aromatic Fluids. Uses : Hydraulic & Fuel Hoses, Oil, Seals.
CR	Chloroprene	Polychloroprene	Neoprene Bayprene Butaclore Skyprene	Dupont Bayer Enichem Toyo Soda Mfg. Co.	Good Weather & Ozone Resistance. Medium Oil Resistance. Flame retarding. Used in products which are exposed to conditions outdoor atmosphere.
EPDM	EPDM	Ethylene Propylene Diene	Keltan Vistalon	DSM, Holland Excon Chemical Co.	Excellent Ozone Resistance. Good Heat, Steam & Weather Resistanc
		Terpolymer	Nordel Roylene Herlene	Dupont Uniroyal Herdillia Unimers Ltd.	Poor Resistance to Aromatic Fluids.
CSM	Hypalon	Chlorosulphanated Polyethelene	Hypalon Toso CSM	Dupont Toyo Soda Mfg. Co.	Excellent Resistance to Ozone Weathering & Acid Medium Resistance to Oils.
VMQ	Silicone	Dimethyl Polysiloxene			Excellent High & Low Temperature Resistance Low Physicals
FPM	Fluorocarbon	Hexafluoropelene Vinylideme Fluoroxide	Viton Fluorel Technoflon	Dupont 3M Ausimont	Medium Oil Resistance. Excellent High Temperature and oil Resistance combined with Chemical Resistance.

APPENDIX - III

POLYMER : It is a Macro Molecule in which the Constituent Molecules are made of one or more Chemical Units linked to each other such that Unit repeat themselves in a large number of times.

ELASTOMER : A Macro Molecular substance which deforms on applying force but returns to original shape on removal of force.

DUREMETER : An Instrument for measuring Hardness of Rubber. It measures Resistance to penetration (without puncturing) of indenter into surface of Rubber.

HARDNESS : Resistance to Indentation.

IRDH : International Rubber Hardness Degrees

TENSILE STRENGTH : The maximum Tensile Force applied during stretching a Test piece till it ruptures it is calculated on original cross sectional area of test piece.

ELONGATION : Increase in length expressed as a percentage of initial length.

MODULUS : It is Tensile Force required to produce a desired Elongation.

COMPRESSION SET : The amount of permanent deformation obtained in a test piece when subjected to standard compressive load for a fixed period of time and at fixed temperature.

VULCANISATION : It is an irreversible process during which a Rubber Compound through a Chemical change in its Structure becomes less Plastic and more Elastic. Elastic nature is extended over a greater range of Temperature. Time, Temperature and Pressure are main factors in Vulcanisation.

MOONEY SCORCH : Measuring of Curing Characteristic of a Rubber compound using Mooney Viscometer.

SCORCH : Premature Vulcanisation of Rubber compound.

UNDERCURE : A state of Vulcanisation less than optimum evidenced by tackiness or inferior physical properties.

OPTIMUM CURE : State of Vulcanisation at which desired combination of all properties are obtained.

CURE TIME : Time required to produce Vulcanisation at given temperature.

ASTM : Abbreviation for American Society for Testing & Materials.

SAE : Abbreviation for Society of Automotive Engineers.

ISO : Abbreviation for International Standard Organisation.

PSI : Abbreviation for Pounds per Square Inch.

MPa : Mega Pascal.

Mn : Mega Newton.

1 MPa = 1 MN/m.sq. = 10.197 kgf/cm.sq. = 145 PSI.

This is the concluding part of earlier published article in last issue.

Troubleshooting Procedure

To aid in troubleshooting, refer to the diagnostic port connections for test gauge installation information. Procedure assumes gauges are installed.

This procedure was written to aid the troubleshooter in following a logical approach to a system fault.

1. Transmission Does Not Drive With The Prime Mover Running.

- | | | | |
|-----|--|-----|--|
| 1.1 | Is there oil in the reservoir? | No | Fill reservoir. |
| | | Yes | Proceed to step 1.2. |
| 1.2 | Is engine clutch engaged? | No | Engage clutch. |
| | | Yes | Proceed to step 1.3. |
| 1.3 | Is the hydraulic piping, in accordance with the hydraulic circuit? | No | Correct the pip |
| | | Yes | Proceed to step 1.4. |
| 1.4 | Is the pump direction of rotation correct? | No | Fit pump having the correct direction of rotation. |
| | | Yes | Proceed to step 1.5. |
| 1.5 | Is there a broken pipe, loose fitting or burst hose? | No | Proceed to step 1.6. |
| | | Yes | Repair the fault. |
| 1.6 | Are the brakes released? | No | Check brake release circuit or mechanism. |
| | | Yes | Proceed to step 1.7. |

Charge Pump and Relief Valve :

- | | | | |
|-----|--|-----|--|
| 1.7 | Is there any charge pressure at port M_1 ? | No | Proceed to step 1.10. |
| | | Yes | Proceed to step 1.8. |
| 1.8 | Is the charge pressure at least 300 psi while the pump is running at normal operating speed? | No | Proceed to step 1.9. |
| | | Yes | Proceed to step 1.19. |
| 1.9 | Can charge pressure be adjusted by adding or removing relief valve spring shims or by adjusting charge pressure relief valve setting screw if so equipped. | No | Proceed to step 1.10. |
| | | Yes | Adjust charge pressure sure to 300 psi and proceed to step |

Note : If flushing valve is used in circuit, it should be set at 25 psi less than charge pump relief. Refer to data sheet on flushing valve for information and setting procedure.

- | | | | |
|------|--|-----|---|
| 1.10 | Is suction line shut-off valve open? | No. | Open valve |
| | | Yes | Proceed to step 1.11. |
| 1.11 | Is the charge pump suction pressure within recommended limits? (-3.2 psig or 6.5 in. Hg vacuum.) | No | Proceed to step 1.12. |
| | | Yes | Proceed to step 1.16. |
| 1.12 | Is suction filter element plugged? | No | Proceed to step 1.13. |
| | | Yes | Replace filter element. |
| 1.13 | Does the reservoir design ensure that suction pipe is always covered with oil? | No | Correct the reservoir design. |
| | | Yes | Proceed to step 1.14. |
| 1.14 | Is the suction pipe size adequate for the flow? | No | Run at lower speed and return to point 1.7, or rework suction piping. |
| | | Yes | Proceed to step 1.15. |
| 1.15 | Is the reservoir air breather blocks or undersized? | No | Proceed to step 1.16. |
| | | Yes | Clean or replace air breather. |

- | | | | |
|------|---|-----|---|
| 1.16 | Remove charge pressure relief valve cartridge and inspect. Is it damaged? | No | Refit cartridge and Proceed to step 1.17. |
| | | Yes | Fit a new cartridge and return to step 1.17. |
| 1.17 | Remove and inspect charge pump assembly. Is it damaged? | No | Proceed to step 1.18. |
| | | Yes | Repair or replace damaged components and return to step 1.7. |
| 1.18 | Is the charge pump installed for correct direction of rotation? | No | Note : Replace charge pump as complete unit. Refit charge pump by rotating pump housing 180°. Return to step 1.7. |
| | | Yes | With proper charge pressure, and transmission still does not operate proceed to step 1.19. |

Pump Control :

- | | | | |
|------|--|-----|--|
| 1.19 | Is control medium connected to pump control? HD-pilot pressure HW-mechanical cable of linkage EL 12 or 24 volts dc, electrical current | No | Connect appropriate medium and check that control signal is actually being applied to the control valve. |
| | | Yes | Proceed to step 1.20. |
| 1.20 | If variable displacement motors are installed, is maximum displacement selected? (If not done automatically). | No | Select maximum displacement. |
| | | Yes | Proceed to step 1.21. |
| 1.21 | Actuate the control in both directions. Does pump stroke? | No | Proceed to step 1.22. |
| | | Yes | Operate the transmission. |
| 1.22 | Stroke the pump in both directions. Do the pressures at X_3 and X_4 alternate between 30 and 250 psi during cycle? | No | Remove control module and replace with new unit. Repeat step 1.21. |
| | | Yes | Proceed to step 1.23. |
| 1.23 | Is the pressure at port R less than 21 psi? | No | Repipe pump case drain line so that case pressure at port R is less than 21 psi. Return to step 1.21. |
| | | Yes | Proceed to step 1.24. |
| 1.24 | Stroke pump in both directions. Does any pressure greater than 350 psi alternate between ports MA and MB | No | Verify that loading of the pump will cause system pressure to increase above charge pressure. |
| | | Yes | Proceed to step 1.19. |
| | | Yes | Proceed to step 1.25. |

Troubleshooting Procedure

1. Transmission Does Not Drive With The Prime Mover Running. (Continued)

1.25	Is it possible to adjust high pressure relief valves using the 0-10,000 psi gauges at M_A and M_B to monitor pressure (Refer to relief valve adjustment.)	Replace high pressure relief valve cartridges and return to step 1.21. Adjust high pressure relief valve to required or design pressure. Proceed to step 1.26.	1.26	Actuate control in both directions. Does transmission run?	No Check if motor sizing is adequate for application. Check for mechanical faults in the drive beyond the motor shaft. Yes Operate the transmission.
------	---	---	------	--	---

2. Transmission Drive Is Sluggish or Erratic

2.1	Is the control medium in good condition? For example: control medium is not in good condition if: HD control-air in pilot lines HW control-sticking cable or linkage EL control-fluctuating control current	No Rectify the control fault. HD-bleed pilot lines HW-lubricate or free the cable or kinkage. EL-check control current Yes Proceed to step 2.2	2.5	Does the charge pressure fluctuate more than 30 psi when stroking the pump?	No Proceed to 2.9. Yes Proceed to 2.6.
2.2	Are the brakes fully released?	No Check brake release circuit or mechanism. Yes Proceed to step 2.3.	2.6	If the charge pump output is used to operate auxiliary functions, do these other functions cause fluctuation in charge pressure?	No Proceed to step 2.8. Yes Proceed to step 2.7.
2.3	Are the stroking time orifices correctly sized for the application?	No Remove the plugs in ports X_1 and X_2 and remove control orifices with 3mm allen wrench, for size 71 and a 5mm allen wrench for size 250. Try various sizes until desired pump stroking rate is attained.	2.7	Isolate the auxiliary function and run the transmission. Are the charge pressure fluctuation reduced or eliminated?	No Proceed to step 2.8. Yes Operate transmission and return to step 2.1.
2.4	With HD control, is the control curve of remote pilot valve correctly matched to the pump?	No Change spring to suit. AA4V pump-curve 05 or 06 of 4TH7 pilot operator. Yes Proceed to step 2.5.	2.8	Are there system pressure fluctuations which are synchronous with the charge pressure fluctuation?	No Proceed to step 2.9. Yes Determine the cause of system pressure fluctuations
			2.9	If variable displacement is used, is motor stroking time correct for the application?	No motor stroking time adjustment valve to the variable motor or modify the control circuit to provide desired stroking time.

Troubleshooting Procedure

3. Transmission Drives In One Direction-Only

3.1	With control lines switched does pump drive in the opposite direction only?	No	Proceed to step 3.2.	3.4	Check flushing valve (if installed) is shuttle spool stuck in one position?	No (Not installed.)	Proceed to step 3.5.
		Yes	Control signal from one side does not work properly. Repair as necessary.			Yes	Remove flushing valve and clean or replace.
3.2	With control lines still switched does pump drive in initial direction only?	No	Proceed to step 3.3	3.5	Switch relief valves. Does transmission drive in the other direction only?	No	Proceed to step 3.6.
		Yes	Problem is in one side of control module or the pump. Proceed to step 3.3			Yes	Repair or replace relief valve on non-driving side.
3.3	Is these control pressure or current from both control lines?	No	Correct control signal problem	3.6	Replace control module and reconnect control lines. Does pump operate properly?	No	Replace or repair pump.
		Yes	Proceed to step 3.4			Yes	Operate transmission.

4. Transmission Drive In The Wrong Direction

4.1	Pump with HD control.	Switch control lines on ports Y ₁ & Y ₂ .	4.3	Pump with HW control.	Rework linkage or cable to give correct drive direction.
4.2	Pump with EL control.	Switch electrical connectors on solenoids A & B.			

5. Pump does Not Find or Hold Neutral (Also refer to pages 19, 20 & 21 of 14th Issue)

5.1	Does pump return to neutral with control lines removed?	No	Proceed to step 5.2.	5.2	Check mechanical centering of pump and control per pages 19, 20 & 21 Does pump return to neutral with control lines removed?	No	Repair or Replace pump
		Yes	Check control for electrical signal problem (EL control), or back pressure in the pilot lines (HD control).			Yes	Replace control module if needed. Operate transmission.

6. Transmission Operates With A High Noise Level

6.1	Are the drive gearboxes filled with correct grade of oil?	No	Fill gearbox with correct grade of oil to the prescribed level.	6.4	Is the suction pressure at the charge pump inlet within recommended limits?	No	Return to step 1.7.
		Yes	Proceed to step 6.2.			Yes	Proceed to step 6.5.
6.2	Is the drive coupling correctly installed and aligned?	No	Install coupling per manufacturer's instructions and tolerances.	6.5	Is there air in the hydraulic oil? This may be indicated by foaming or milky colored oil.	No	Proceed to step 6.6.
		Yes	Proceed to step 6.3.			Yes	Deaerate the oil and inspect system for cause of air induction.
6.3	Is rigid piping connected to the pump?	No	Proceed to step 6.4.	6.6	Is the hydraulic motor operating at excessive speed?	Yes	Check motor sizing in relation to available oil flow from the pump.
		Yes	Install short length of hose between pressure ports of the pump and the system piping				

Troubleshooting Procedure

7. Transmission Operates At a Higher Than Normal Temperature

7.1	Is the operating temperature above 195°F?	No	195°F is the upper limit. If temp. is close to 195°F, the oil cooler may need to be cleaned.	7.4	Check differential pressure across oil cooler as compared to the manufacturer's spaces at charge pump flow.	No	Proceed to step 7.5.
		Yes	Proceed to step 7.2.			Yes	Check piping from oil cooler to the reservoir.
7.2	Is the hydraulic motor stalling intermittently?	No	Proceed to 7.3				Check for plugged or damaged cooler
		Yes	Hydraulic oil is being heated through system relief valves. shut down system and rectify cause of the motor stall.		is P higher than it should be?		
				Note: Max. case pressure is 30 psi.			
7.3	Does temperature remain above 195°F after cleaning oil cooler?	No	Operate transmission. Check oil cooler more often.	7.5	Disconnect pump case drain from oil cooler and check flow from charge pump. Is flow normal?	No	Refer to pump remove and inspection procedure.
		Yes	Proceed to step 7.4.			Yes	Check oil cooler location.

8. Pump Does Not Develop Maximum Horsepower (Flow & Pressure)

8.1	Does charge pressure meet specification?	No	Return to 1.9.	8.3	Are the high pressure relief valves adjusted to the required pressure so that they do not by-pass?	No	Adjust or replace relief valve cartridge.
		Yes	Proceed to 8.2.			Yes	Replace the pump.
8.2	Is the case pressure less than 30 psi?	No	Check sizing of return lines from T port of pump and the cooler sizing related to flow.				
		Yes	Proceed to 8.3	Note : If pressuer override valve is fitted to rump. check that pressure setting is sufficient for the application.			

Adjustment of Pressure Override Valve

Function of Pressure Override :

The pressure override valve varies the swashplate angle, as required, to limit the maximum pressure at port A or B. The override valve prevents continuous dumping of excessive flow, at load pressure, through the cross port relief valves contained in the pump. This eliminates unnecessary heating of the oil and protects the pump and motor from heavy-handed operators, or, if the drive stalls causing the pump to deadhead. The pressure override valve should be adjusted to a pressure 500 psi less than the setting of the main relief valves.

Adjustment Procedure

The method of adjusting the pressure override (P.O.R.) valve is the same, regardless of whether this option is fitted to a remote hydraulic pilot (HD), rotary manual servo (HW), or proportional electric (EL) displacement control. Although the physical appearance of the rotary manual servo control (HW) with P.O.R. is different from the other two displacement controls, the function is identical.

Following is a suggested procedure for adjusting the P.O.R. it is assumed that high pressure gauges are connected to ports M_A and M_B . Some applications may require a slight departure from the procedure.

1. Block the output flow from the high pressure ports A & B, or lock the hydraulic motor by applying the brake.
2. Turn both high pressure relief valve adjusting screws counterclockwise until the spring tension is completely relieved, then turn both adjusting screws one full turn clockwise.
3. Turn both P.O.R. adjusting screw in (clockwise) until firm resistance is encountered. Do not force the adjustment beyond this point.
4. Stroke the pump to approximately 20 percent of full flow in one direction and adjust the high pressure relief valve for that flow direction to a pressure which is 500 psi higher than the required P.O.R. pressure setting.
5. Repeat step 4 for the opposite direction of flow.

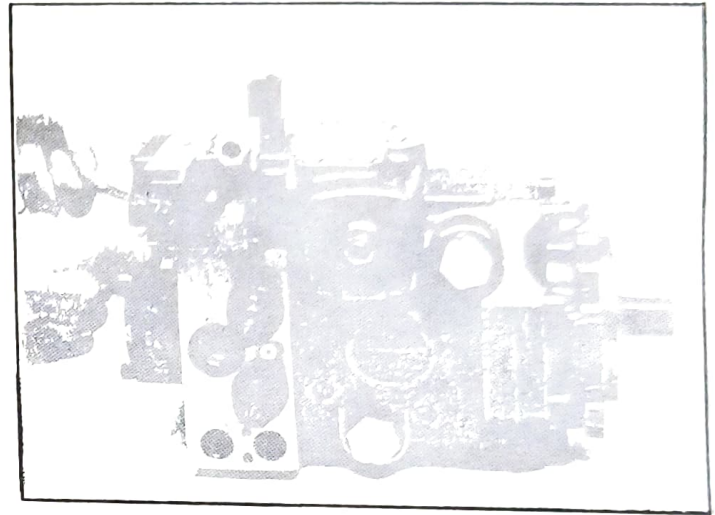
Note:

Perform steps 4 & 5 as quickly as possible to prevent overheating of the pump. Flow should not be permitted to spill over the high pressure relief valves for longer than 10 seconds, especially at higher pressure.

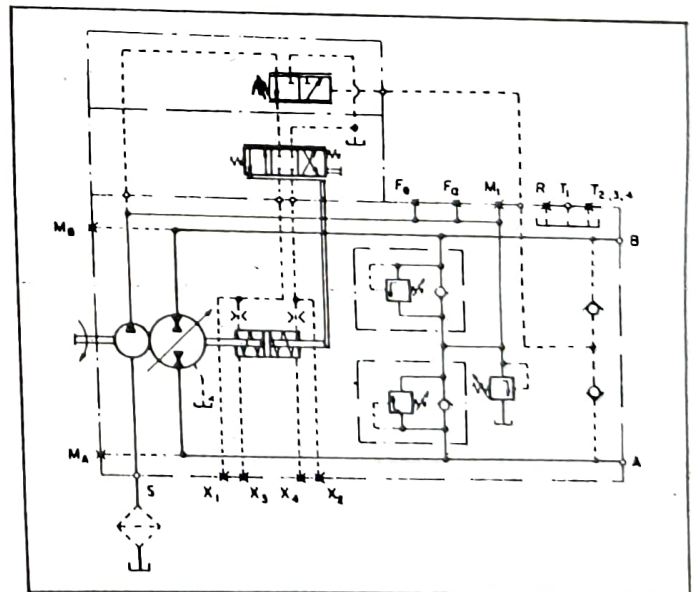
6. Neutralize the pump control and turn P.O.R. adjusting screw counterclockwise, all the way out.
7. Stroke the pump fully in either direction, then turn the P.O.R. adjusting screw in (clockwise) until the desired pressure setting is achieved.
8. Stroke the pump for opposite flow direction to that used in step 7 and check the operation of the P.O.R. Equal maximum pressure be seen both sides of centre.

Note:

All adjustment require a 3mm allen wrench and 10mm box wrench except for size 71 pump, which can use 5mm allen wrench and 17mm box wrench for the high pressure reliefs.



Adjustment of P.O.R. valve on pumps with remote hydraulic pilot control, type HD, manual rotary servo type HW, and proportional electric control, type EL (Illustrated.)



Circuit schematic of AA4V hydrostatic transmission pump with P.O.R. HW control is shown. Other control types use same P.O.R. schematic.

E D I T O R I A L

Dear Reader,

Now 15th issue of IRTM digest is with you. This is your digest. Please contribute articles on Track Machines like improvement in operation, maintenance, overhauling, quality control and optimum utilisation.

Thanks.

Surya Prakash

Principal



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