



Ford Motor Company Limited

Central Office

January 18th 1984.

Mr R.J. Donnellan, Senior Attorney
Office of the General Counsel,
Ford Motor Company,
Parklane Towers West,
One Parklane Boulevard, Suite 300,
Dearborn, Michigan 48126, U.S.A. ,

Dear Mr Donnellan,



Eagle Way
BRENTWOOD Essex CM13 3BW
Telex: 995511

Subject: EXPOSURE TO ASBESTOS FROM BRAKE LININGS

As you are probably aware I had an extended telephone conversation with Mr Krause on Tuesday 10th January 1984, during which, I believe I gave answers to the questions posed in Mr Krause's letter of December 14th 1983.

I enclose the following sets of documents which were requested by Mr Krause

1. Correspondence relating to the 1969 Conference.
2. Internal reports upon which the Ford Conference Papers were based.
3. Correspondence with Mr J. Lynch.
4. Published proceedings of the 1969 Conference.
5. Correspondence regarding commercial developments of the drum cleaning unit.
6. Service information - cars.
7. Service information - trucks.

With regard to question No.9, the Health and Safety Executive have now confirmed to me that while there were internal reports regarding exposure to asbestos from brake linings, there was no public guidance published on the subject, such as Regulations, Guidance Notes etc.

With regard to question No.10, I have written to the firm who developed the drum cleaning unit, to ascertain when this was first marketed in the UK.

I hope that my telephone call and this letter and attachments, give you the information you require, but please let me know if there is any further way in which I can be of assistance to you.

Yours sincerely,

Dr D.E. Hickish
Industrial Hygiene Specialist.

Telephone: Brentwood (0277) 25 3350 Making Reference (Please include in Envelope Address) Room 17/163

cc: mr R. Krause.

Registered in England: No. 235446 Registered Office: Eagle Way BRENTWOOD Essex CM13 3BW

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Internal reports upon
which Conference papers
were based.

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HFM - 005787

Report 41/68

Exposure to Asbestos during the
Servicing of Brakes of Passenger
Cars

July 1968

D E Hickish

Dr D E Hickish - 1/163
Industrial Hygiene
Specialist

8006 1202

I INTRODUCTION

This investigation was undertaken in view of the increased national concern regarding exposure to asbestos, and of the impending revision of the Asbestos Regulations of the Ministry of Labour.

One of the operations within the motor industry which could involve exposure to asbestos dust is the cleaning of brake drums and clutch assemblies, normally carried out during routine servicing by "blowing-out" with compressed air jets.

The brake linings in current use may contain 40 to 60% asbestos when manufactured - the asbestos being normally in the chrysotile form, and occasionally in the amosite form. Crocidolite asbestos is said not to be used.

II FIELD INVESTIGATION

It was considered that any hazard to health from exposure to brake-drum or clutch dust would be more widespread within the Dealer Repair Organisation than within Ford of Britain, so the initial investigation was carried out at a large Main Dealer service bay. At this garage, the number of cars per day given a routine service varies between 10 and 20, but not all servicing involves brake cleaning.

Air sampling was carried out initially on two occasions, A and B, using thermal precipitators (T.Ps) as the sampling instruments. On the second occasion, samples were also collected on membrane filters. This latter technique has been developed in recent years, and is likely to become the preferred method of sampling for asbestos in Great Britain and the U.S.A.

... In

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In each case, measurements were made:

- (a) By the side of cars being given a service which included brake cleaning, and
- (b) In the dust-cloud during brake cleaning, and then near to the car for the remainder of the service period.

As the mechanic normally blows the dust away from himself, the sampler at (b) would be exposed during "blow-off" to dust concentrations greater than those actually pertaining at the breathing zone. It was considered, however, that to sample in this way would provide an additional factor of safety. Details of the sampling are given in Table 1.

A further period of air sampling, C, was carried out, when membrane filter samples were collected from the breathing zone of the brake-clean operative, by means of a personal sampler, with suitably modified flow rate (approx. 250 cc/min.). The sampling covered an entire work shift, during which brake blow-out was carried out on the following vehicles:

- 5 Corsairs
- 1 Zodiac
- 4 Cortinas
- 1 Prefect

The thermal precipitator slides were subsequently incinerated and examined by micro-projection using a 4 mm objective and X.17 eyepiece. The membrane filter samples were rendered translucent by the addition of triacetin, and examined in a similar manner. Phase contrast microscopy was not used.

The results of the T.P. counts for occasions A and B are given in Table 2, and for the membrane counts on the

... occasions

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occasions B and C in Table 3. The counts are expressed in terms of particles with diameter greater than 1μ , and of fibres (i.e. particles with aspect ratio greater than 3:1 and length greater than 5μ).

III LABORATORY INVESTIGATION

In view of the relatively few fibres present in the air samples, a laboratory investigation was undertaken, comprising microscopic examination of samples from brake lining material (which was filed to produce dust) and brake drum dust (collected by spatula from brake drums immediately prior to blowing-out). The samples were sieved through 200-mesh screens and then examined before and after incineration.

The results are shown as fibre proportions in Table 4.

Samples of material collected from the brake drums of (a) an Anglia van, (b) a Mark II Cortina, and (c) an Anglia car were analysed by Dr S Holmes of Messrs. Turner Brothers Asbestos Co.Ltd., and his findings are shown in Table 5.

IV DISCUSSION OF RESULTS

(a) Standards of dustiness

In June 1968, the British Occupational Hygiene Society published a Hygiene Standard for Chrysotile Asbestos Dust, which suggested that in order to reduce the risk of contracting asbestosis to 1% of those with a lifetime's exposure to the dust, the accumulated exposure should not exceed 100 fibre-years/cc, i.e. 2 fibres/cc for 50 years, or 4 fibres/cc for 25 years. In this standard, fibres are

... defined

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defined as those exceeding 5µ in length, as determined by the membrane filter method.

Categories of dustiness are designated as follows:

<u>Dust Category</u>	<u>Concentration averaged over 3 months (Fibres/cm³)</u>
Negligible	0 - 0.4
Low	0.5 - 1.9
Medium	2.0 - 10.0
High	Over 10.0

As an alternative index, a thermal precipitator count of 25 particles/cc greater than 1µ after incineration is regarded as equivalent to 2 fibres/cc by membrane filter count.

While it is considered unlikely that a mechanic will be engaged on brake cleaning for a working lifetime of up to 50 years, an additional factor of safety should be provided if a Threshold Limit Value (TLV) of 2 fibres/cc, i.e. corresponding to this length of exposure, is adopted in considering the results of the present air sampling.

(b) Field investigation

The thermal precipitator particle counts are in excess of the alternative TLV of 25 particles/cc. but these counts would include many non-asbestos particles - road dust etc., whereas the TLV was determined from counts within asbestos factories. The fibre counts by thermal precipitator are lower than those obtained by membrane filter.

Membrane filter counts show a concentration in the general atmosphere below the TLV, except when the sampler is placed in the dust cloud during blow-out. The personal

... exposure

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exposure is shown to be at a level of 1/3 of the TLV, and corresponds to a "low" dust category.

(c) Laboratory investigation

It is, at first sight, surprising that the exposure to asbestos is as low as found, in view of the quantity of asbestos present in the original material of the brake linings.

Comparison of the fibre proportions in brake lining material and brake drum or air-borne dust (Table 4) shows that in the latter, the percentage of fibres is greatly reduced. The analyses of the brake drum dust samples confirm a very low asbestos content. These findings suggest that during usage, the material undergoes changes in physical and/or chemical form.

Enquiries from research workers in UK and USA indicate that this is a finding which has been observed elsewhere, and current thought is that during braking, high point contact temperatures are reached. As a result, thermal decomposition of chrysotile asbestos takes place, producing an amorphous, non-fibrous magnesium silicate. Under very extreme operating conditions, the binder may decompose and release part of the asbestos as free fibre, but such circumstances would be most unusual.

(d) Conclusions

On the environmental and analytical evidence obtained, it does not appear that a significant hazard to health should occur during brake drum blow-out in a typical Dealer Passenger Car Repair Shop. It would be helpful, however, for

... clinical

8006 1207

clinical examinations to be made of some repair mechanics with long experience of brake cleaning to confirm this view.

It would also be desirable to include in Service manuals, a general instruction that inhalation of dust during brake cleaning should be minimised, and if practical alternative methods, which would produce less dust, can be devised, their use should be recommended.

The present investigation has been confined to servicing of passenger cars, and a further study of heavy vehicle servicing is under consideration.

Table 1. Details of air sampling

Sample No.	Type	Location	Duration mins. (approx)	Activity during sample period
<u>Day A</u>				
A1	T.P.⊗	(a) Static by car	30	1 Cortina
A2	"	(b) Dust cloud, then static	30	1 Cortina
A3	"	(b) " " " "	45	1 Corsair
A4	"	(a) Static, by car	45	1 Corsair
A5	"	(b) Dust cloud, then static	35	1 Corsair
A6	"	(a) Static, by car	30	1 Corsair
<u>Day B</u>				
B1	T.P.)	(a) Static, by car	45	{ 1 Cortina
B2	M.✓)		45	{ Estate 1 Anglia Van
B3	T.P.)	(b) Dust cloud, then static	45	{ 1 Cortina
B4	M.)		45	{ Estate 1 Anglia Van
B5	T.P.)	(a) Static, by car	35	1 New Cortina
B6	M.)		35	
B7	T.P.)	(b) Dust cloud, then static	35	1 New Cortina
B8	M.)		35	
<u>Day C</u>				
C1	M.	Personal sample	60	1 Corsair
C2	"	" "	56	{ 1 Corsair 1 Zodia
C3	"	" "	59	None
C4	"	" "	56	{ 1 Cortina 2 Corsairs
C5	"	" "	60	{ 1 Cortina 1 Prefect (part)
C6	"	" "	64	1 Prefect (contd.)
C7	"	" "	70	{ 2 Cortinas 1 Corsair

⊗ T.P. Thermal Precipitator

⊗ Membrane

8006 1209

Table 2. Results of Thermal Precipitator Samples

Sample No.	Sample details	Sample time mins.	Dust concentration	
			Particles/cc (>1 μ)	Fibres/cc (>5 μ)
	(a) <u>Static - by car</u>			
A1		30	99	2
A4		45	134	1
A6		30	62	2
	Time-weighted average		103	1.57
B1		45	124	0.5
B5		35	102	0
	Time-weighted average		115	0.28
	(b) <u>In dust cloud, then static</u>			
A2		30	71	3
A3		45	141	2
A5		35	92	0
	Time-weighted average		106	1.64
B3		45	108	0.5
B7		35	181	0.2
	Time-weighted average		137	0.37

Table 3. Results of Membrane Filter Counts

Sample	Details	Sample time mins.	Fibres/cc.
<u>I. General atmosphere samples</u>			
	(a) <u>Static by car</u>		
B2		45	1.12
B6		35	1.42
	Time-weighted average		1.25
	(b) <u>In dust cloud, then static</u>		
B4		45	1.71
B8		35	3.62
	Time-weighted average		2.55
<u>II. Personal samples</u>			
C1		60	0.63
C2		56	1.12
C3		59	0.21
C4		56	0.96
C5	Sample lost		
C6		64	0.38
C7		70	0.79
	Time-weighted average		0.68

8006 1211

Table 4. Fibres - as percentage of total particles
 observed

Sample	Fibre proportion --%	
	Un-Incinerated	Incinerated
Brake lining material	28	12.3
Brake drum dust	0.6	1.6
Air-borne dust	-	1.3

Table 5. Analysis of Brake drum dust

Sample	Electron diffraction microscopy	X-ray diffraction (normal specimen)	X-ray diffraction (extracted specimen)
1.Anglia Van	Chrysotile present	Iron & quartz present. No chrysotile detected.	Less than 5% chrysotile, possibly 0.1% to 1%.
2.Cortina Mk.II	"	"	Less than specimen 1.
3.Anglia car	"	"	As specimen 1.

8006 1212

Report 52/68

Exposure to Asbestos Dust during
Brake Maintenance Operations on
Commercial Vehicles, Fleet Repair
Garage, Dagenham

October 1968



Dr D E Hickish - 1/163
Industrial Hygiene
Specialist.

8006 1213

I INTRODUCTION

This study was undertaken to assess the degree of exposure to fibrous dust in brake maintenance procedures on commercial vehicles and to provide comparative data relating to a previous study on operators working on passenger cars.

II INVESTIGATION

Air sampling took place in the garage on the 19th September 1968. Membrane filters, in conjunction with Casella personal samplers, suitably modified to provide a flow rate of 200 cm³/min. were used and the following sampling procedure adopted.

(a) Personal samples were collected from the "brake blow off" operator (Mr Crone) and the mechanic working in the adjacent bay (Mr Hillman) during the blowing-off operation. The filters were then changed and replaced to run for the rest of the shift.

(b) Static samplers were positioned at three points, A, B and C, about 20-25' from the source of dust generation and separate samples were collected for the morning and afternoon shifts.

The sampling positions are shown in Fig.1.

The collected samples were subsequently removed to the laboratory and, after preparation, examined by projection microscopy for the presence of fibres greater than 5µ. (A fibre is defined as having an aspect ratio equal to, or greater than, 3:1).

... III RESULTS

III RESULTS

Table 1 shows the fibre counts per cm^3 for each sample collected.

IV DISCUSSION OF RESULTS

(i) Standards of dustiness

In a previous Report (41/68: Exposure to Asbestos during the servicing of brakes of passenger cars) reference was made to the Hygiene Standard for Chrysotile Asbestos Dust proposed by the British Occupational Hygiene Society. This standard suggested a Threshold Limit Value of 2 fibres/ cm^3 for an exposure period of 50 years.

Categories of dustiness were proposed as follows:

<u>Dust Category</u>	<u>Concentration, fibres/cm^3</u> <u>(averaged over 3 months)</u>
Negligible	0 - 0.4
Low	0.5 - 1.9
Medium	2.0 - 10.0
High	10

(ii) Field Investigation

Static Samples

As the blowing-off operation took place in the early part of the morning shift, the concentrations obtained at the static positions during the afternoon shift (samples 8, 9, 10) probably represent the background contamination. Thus it can be seen that the generation of a dust cloud by blowing off dust from commercial vehicle brakes results in increased background contamination of 3 to 4 times the background level at any point within a radius of 20-25 ft.

The concentrations are all well below the TLV, and with one exception come within the "Negligible" dust category.

... Personal

Personal samples

The fibre concentrations for the mechanic engaged on the blowing-off task taken for the duration of the operation shows an exposure of nearly 4 times the TLV, while the concentration measured in the breathing zone of the mechanic working in the adjacent bay during the same period just exceeded the TLV.

The personal samples from the two mechanics taken over the remainder of the shift give similar results. When the samples for the two mechanics are calculated on the basis of time-weighted concentrations, the exposures are below the TLV and come within the "Low" dust category.

V

CONCLUSIONS

In the light of the environmental data, and of the irregular intervals at which brake-cleaning is carried out (it is not a daily procedure) it does not appear that a significant hazard to health should occur in the case studied.

Nevertheless, the conditions which obtain during the blowing-out operation are extremely unpleasant, and alternative methods of cleaning should be investigated, or measures adopted to minimise personal exposure, e.g. local ventilation, or use of a suitable respirator.

Table 1. Results of Membrane Filter Counts

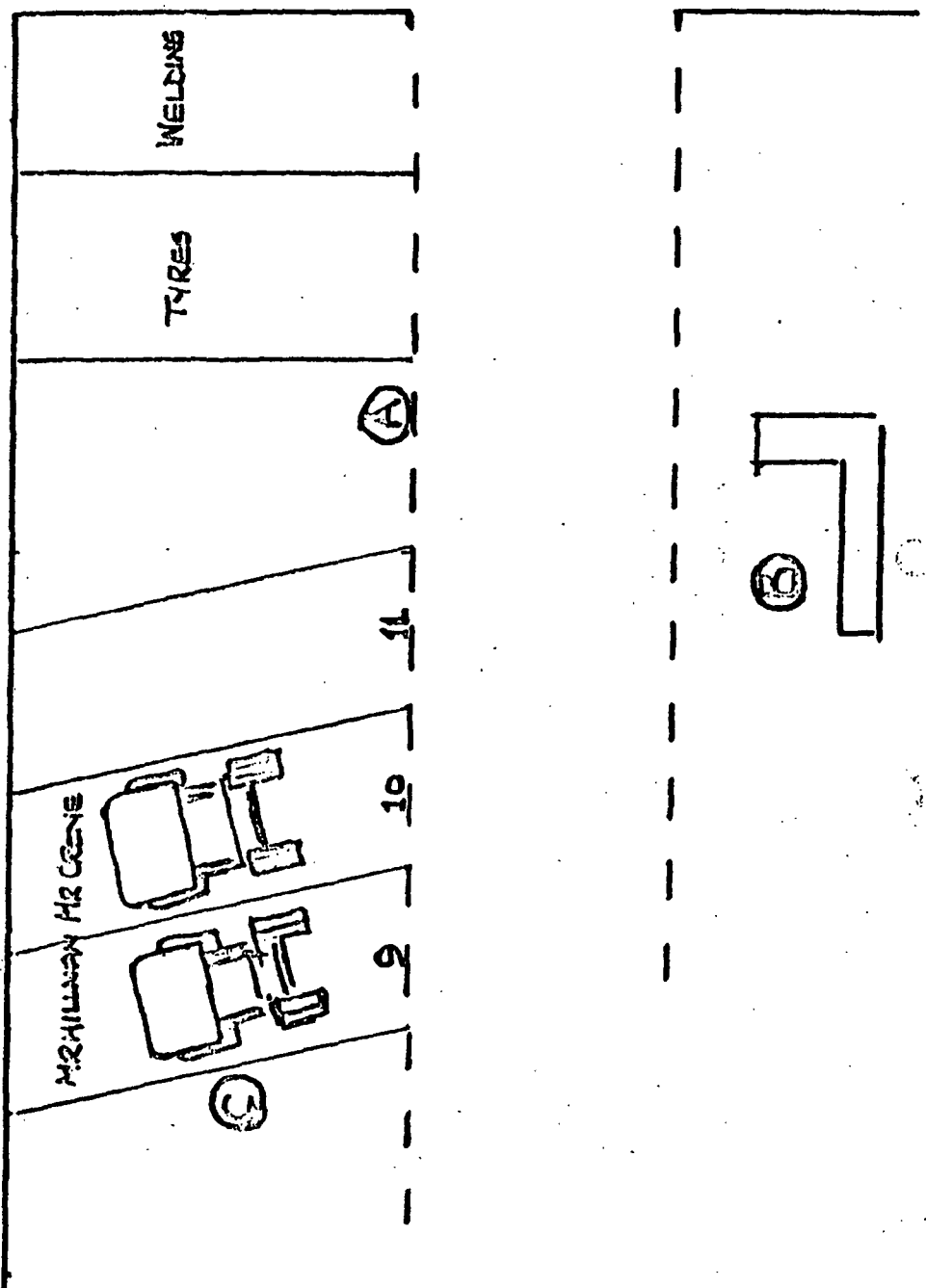
Sample No.	Description	Duration mins.	Flow Rate ml/min.	Concentration fibres/cm ³	Dust Category
1	Personal. Mr Crone. Brake maintenance. Front brakes blown out in this period	99	193	7.09	Medium
2	Personal. Mr Hillman. Clutch repair procedure at adjacent vehicle bay	127	207	2.25	Medium
3	Static. Position A.	190	232	0.17	Neg.
4	Static. Position B.	185	133	0.49	Neg/Low.
5	Static. Position C.	180	206	0.28	Neg.
6	Personal. Mr Crone. One rear brake assembly blown off at beginning of sampling period.	317	180	0.08	Neg.
7	Personal. Mr Hillman. Clutch repair procedure at adjacent vehicle bay.	278	148	0.11	Neg.
8	Static. Position A.	186	211	0.07	Neg.
9	Static. Position B.	186	170	0.11	Neg.
10	Static. Position C.	185	172	0.07	Neg.
Time-weighted average concentrations:					
Mr Crone				1.75	Low
Mr Hillman				0.79	Low

8006 1217

SKETCH OF ARRANGEMENT OF
SAMPLING SCHEME AT REPAIR GARAGE
19 SEPTEMBER 1968



Fig 1



Report 69/68

8006 1218

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Correspondence with
Mr. Lynch.

8006 1194

6 December 1967

Mr H E Ayer B.S.
Division of Occupational Health
U.S.P.H.S.
1014 Broadway
Cincinnati, Ohio, U.S.A.

Dear Mr Ayer,

I understand that you have recently been investigating the generation of free asbestos arising from the decomposition of brake shoes.

This is a subject which we are concerned with at the moment, particularly with regard to service operations involving the cleaning of brake assemblies by compressed air jets.

I should be most interested to receive from you any of your publications which relate to this problem and, in particular, to hear of any views which you may have regarding the state of the asbestos in the dust which accumulates in automobile brake drums.

Kind regards.

Yours sincerely

Dr D E Hickish
Industrial Hygiene Specialist

3350

Room 1/163 DEH/VJS

8006 1195



DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

January 17, 1968

NATIONAL CENTER FOR
URBAN AND INDUSTRIAL HEALTH
1014 BROADWAY
CINCINNATI, OHIO 45202

REFER TO:

Dr. D. E. Hickish
Industrial Hygiene Specialist
Ford Motor Company Ltd.
Warley, Brentwood, Essex, England

Dear Dr. Hickish:

Mr. Ayer has asked me to reply to your letter on brake lining decomposition.

The enclosed draft of a report on brake decomposition summarizes some of the early work we have done on this subject. Further work has generally confirmed the conclusion that brake linings give off very few free fibers except under extreme operating conditions.

With regard to the cleaning of brake assemblies in service garages, electron micrographs of the dust removed from brake drums has shown it to contain mostly road dirt and rust with very few fibers. What fibers were released by the lining have apparently escaped into the air. However, some other service garage operations, such as radius grinding and burnishing, which abrade the brake surface, will produce dust clouds containing free fibers similar to those found in brake lining manufacturing plants. To evaluate these situations I would recommend fiber counts on membrane filter samples as described in the attached preprint by Edwards and Lynch. The British Occupational Hygiene Society has adopted a limit of 2 fibers/cc longer than 5 μ .

Some other articles which may be of interest are also enclosed. Please let me know if I can be of any further assistance.

Sincerely yours,

Jeremiah R. Lynch
Jeremiah R. Lynch
Asst. Chief, Environmental
Activities
Field Studies
Occupational Health Program

22 JAN 1968

Enclosures

8006 1196

30 January 1968

Mr Jeremiah R Lynch
Asst. Chief, Environmental Activities
Field Studies
Occupational Health Program
Department of Health, Education and Welfare
National Center for Urban and
Industrial Health
1014 Broadway
Cincinnati, Ohio 45202.

Dear Mr Lynch,

I am writing to thank you for the most useful information contained in your letter and attachments of 17 January 1968 regarding brake lining decomposition.

Our studies so far are in agreement with your findings in that we have been unable to find fibres during brake cleaning in service garages using thermal precipitators and membrane filters.

With many thanks.

Yours sincerely

Dr D E Hickish
Industrial Hygiene Specialist

3350

Room 1/163 DEH/VJS

8006 1197

At this point I must have sent
Mr. Lynch a draft of my paper so
that he could check my reference
to his work, and to our correspondence.

PSH.
18/1/84.



DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

Consumer Protection and Environmental Health Service
Environmental Control Administration

REFER TO:

NATIONAL BUREAU OF ENVIRONMENTAL HEALTH
1014 BROADWAY
CINCINNATI, OHIO 45202

17 JUN 1969

June 13, 1969

Dr. D. E. Hickish
Industrial Hygiene Specialist
Ford Motor Company Limited
Brentwood
Essex, England

Dear Dr. Hickish:

The report you wish to refer to has since been published in the Journal of the Air Pollution Control Association (copy enclosed).

I am not sure I agree with the last sentence in your summary of my conclusions. At bulk lining temperatures of 600-700°F the binder simply burns and lets the asbestos fiber loose. At lower bulk temperatures, within normal operating range, the spot temperature at the point of contact between the lining and drum may be very high, higher even than the decomposition temperature of asbestos. The binder behind the surface remains intact, since it is not nearly as hot, and micro-ablation occurs at the point of contact. This explains why Sinclair at the Johns-Manville laboratories found the magnesium from the chrysotile in the decomposition product but not the x-ray diffraction pattern of chrysotile. The fibrous asbestos had been changed to another, non-fibrous, mineral by the intense heat at the point of contact. Thus, I do not believe that the asbestos comes off unaltered, encapsulated in the binder.

Please let me know if I can provide any further assistance.

Sincerely yours,

Jeremiah R. Lynch
Chief, Laboratory of Engineering
Bureau of Occupational Safety
and Health

Enclosure

8006 1199

1 July, 1969

Mr J R Lynch
Department of Health, Education
and Welfare
Public Health Service
1014 Broadway
Cincinnati
Ohio 45202

Dear Mr Lynch,

Thank you for your letter of June 13, 1969, and for the copy of your Paper entitled 'Brake Lining Decomposition Products'.

The last sentence in my summary of your conclusions was taken from the draft report which you sent me in January, 1968, but I see that your views have now changed. I suggest, therefore, that the final part of my reference to your work should read as follows: "At lower bulk lining temperatures within the normal operating range, the binder behind the surface remains intact. However, the spot temperature at the point of contact between the lining and the drum may be higher than the decomposition temperature of asbestos. The decomposition product, therefore, includes not free asbestos fibres but a different mineral, resulting from thermal metamorphosis."

I hope that this reference to your work is now acceptable to you and unless I hear from you to the contrary I will publish it in this form.

Yours sincerely,

D E Hickish
Industrial Hygiene Specialist

3350

1/168

8006 1200

Published Proceedings
of 1969 Conference

8006 2127

Vol. 13, No. 1 January 1970

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Contents

PREFACE

D. B. HICKISH: Exposure to asbestos during brake and clutch maintenance

W. J. SMITH: Asbestos and asbestosis

S. A. ROACH: Hygiene standards for asbestos

D. B. HICKISH and K. L. KNIGHT: Exposure to asbestos during brake maintenance

S. LUXON: Technical implementation of the new asbestos regulations

D. HATCH: Possible alternatives to asbestos as a friction material

M. I. BENTLEY: Control of the use of asbestos-containing friction materials

G. I. LEE: Removing dust from brake assemblies during vehicle servicing - alternative cleaning methods

K. L. KNIGHT and D. B. HICKISH: Investigations into alternative forms of control for dust generated during the cleaning of brake assemblies and drums

S. LUXON: Respirators for protection against asbestos

R. R. A. COLES and C. G. RICE: Towards a criterion for impulse noise in industry

J. G. WALKER: Temporary threshold shift from impulse noise

A. M. MARTIN, G. R. C. ATHERLEY and T. J. HAMMROCK: Recurrent impact noise from pneumatic hammers

W. G. NORTON: A new concept of damage risk criterion

Letters to the Editor:

H. A. BAMBER and R. BUTTERWORTH: Asbestos hazard from protective clothing

M. GREENBERG: Asbestos release from battery boxes

News Items

Book Review



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PREFACE

Exposure to Asbestos during brake and clutch maintenance

THE PAPERS which follow were originally presented at a Conference held at the Central Office, Ford Motor Co., Brentwood, Essex, on 26 March 1969. The Chairman of the Conference was Dr G. H. Channing, Chief Medical Officer, Ford of Britain, who opened the proceedings by outlining the events which had led to the arranging of the Conference.

Publication of the proposed Asbestos Regulations by the Department of Employment and Productivity had raised queries within the motor industry as to whether clutch and brake maintenance activities, both at the manufacturers' premises and within the repair trade, would come within the requirements of the Regulations. There was a general desire that the subject should be investigated, and any necessary remedial measures sought, in advance of the legislation so that Dealers could be advised and servicing procedures modified where this might be necessary. Investigations had been made by the Industrial Hygiene Units of the British Motor Corporation, and of Ford of Britain, and their findings would be reported to the meeting. These would be preceded by papers on the medical aspects of exposure to asbestos, and later in the programme there would be papers indicating possible solutions to the problems involved.

D. E. HICKISH

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ASBESTOS AND ASBESTOSIS*

W. J. SMITHER

Group Medical Adviser, Cape Asbestos Company, 114 Park Street, London W.1.

THE FORMS AND USES OF ASBESTOS

COMMERCIALY important asbestos fibres fall into two main groups. The first of these is chrysotile, and the second comprises the amphiboles. Both groups are fibrous silicates, but they differ in geological origin, in chemical composition, in molecular structure, in fibre size and strength, and in other characteristics. Chrysotile, white asbestos, comes from many different places. There are slight chemical and physical variations in the fibres from different sources, but basically all have the same molecular structure. On the other hand, the amphiboles comprise at least three separate types, whose molecular structure is very similar, but whose chemical and physical properties differ more widely. Amosite (amber) and crocidolite (blue) are of commercial importance in this country, whereas anthophyllite is a Finnish fibre not used here.

The relative amounts of each fibre in world production is shown in Fig. 1 and the areas of main use in Fig. 2.

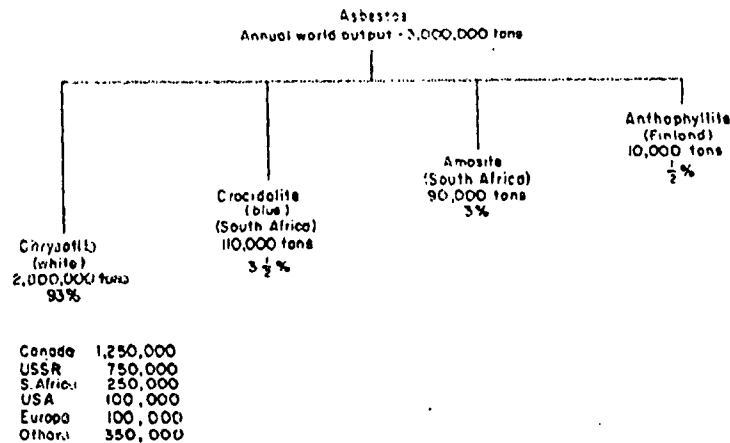


FIG. 1. World production of asbestos.

*This paper was originally presented at a Conference on Exposure to Asbestos during Brake and Clutch Maintenance, held at Brentwood, Essex, March, 1969.

W. J. SMITH

Asbestos
Annual consumption-3,000,000 tons

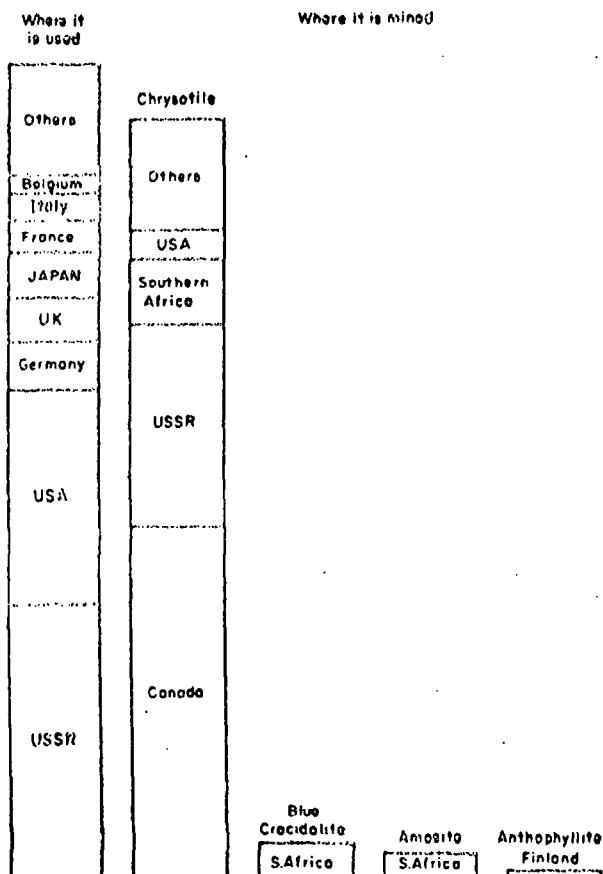


FIG. 2. Areas of use of asbestos.

The different characteristics of asbestos fibres dictate their uses, their applications and their mode of packing and handling. For example, amosite can be pressure packed and palletized, whereas chrysotile lends itself more readily to containerization. By far the greatest use of chrysotile is in the asbestos cement industry. Amosite is used mainly in insulation and building products. Crocidolite, due to its excellent acid resistance, finds its major application in the manufacture of battery boxes in this country. It is added to the pitch mixture in unopened dissoluble bags.

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Very broadly it can be said that current friction materials, whether they be disc brake pads, passenger car and commercial vehicle brake linings or clutch facings, contain 50 per cent chrysotile asbestos. The new trends of development, particularly in the fields of disc brake pads and commercial vehicle brake linings, indicate that the percentage of asbestos included in the mix is likely to decline. Some new materials now contain approximately 40 per cent asbestos, and newer mixes can be foreseen with an even lower percentage, probably down to a minimum of 30 per cent. The pads for disc brakes require less asbestos fibre than conventional drum brake linings. It is estimated that more and more passenger cars produced in the U.K. will in future be equipped with disc brakes, particularly on the front wheels.

THE BIOLOGICAL EFFECTS OF ASBESTOS

The variation existing in the biological effects of the different types of asbestos is the subject of considerable interest and research, and the extent to which the physical and chemical characteristics of the asbestos itself influence biological effects is being investigated. The role of trace elements and contaminants associated with the fibres has also to be considered.

The chief biological effects of asbestos are confined to the lung and the pleura, or lining of the lung and chest cavity, and to the peritoneum, or lining of the abdominal cavity. A few cases of skin corns have occurred in asbestos workers, but these are becoming much less common.

All types of asbestos, if inhaled in fairly high concentrations over a considerable period of time, may cause fibrosis of the lungs. This disease, called asbestosis, consists of thickening of the lung membranes with resultant stiffening of the tissues and interference with oxygen uptake. The interference with gas transfer is the reason for the shortness of breath which causes the disability associated with asbestosis.

The amount of exposure required to produce fibrosis of the pleura, with or without calcium deposition in the scars, is more debatable. It may be that shorter, less concentrated exposures, particularly in youth, leave this mark upon the pleura. In any event this particular effect of asbestos inhalation causes little or no disability in itself.

Exposure to asbestos may lead to further complications, e.g., heart failure, cancer of the lung, or, rarely, to malignant changes in the pleura or peritoneum, known as mesothelioma. Cancer of the lung has been shown to be more common in asbestos workers who smoke, just as it is in the general population. Mesotheliomas are very uncommon throughout the world, but in some areas they have been associated more frequently with exposure to crocidolite than to chrysotile, amosite or anthophyllite. The reasons for this are at present obscure, but are being sought intensively by investigators in many different countries.

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HYGIENE STANDARDS FOR ASBESTOS*

S. A. ROACH

London School of Hygiene and Tropical Medicine, Keppel Street, London W.C.1.

As LONG as there is any airborne asbestos dust in the work environment there may be some small risk to health. Nevertheless exposure up to certain limits can be tolerated for a lifetime without incurring undue risks.

A hygiene standard for asbestos was published in the U.K. by the Ministry of Labour in 1960 and was taken from the annual list of Threshold Limit Values of the American Conference of Governmental Industrial Hygienists (ACGIH) (Committee on Threshold Limits, Annually).

The British Occupational Hygiene Society formed a Hygiene Standards Committee in 1965 to advise on hygiene standards. This Committee recommends the use of the ACGIH list of standards and supplements this with critical examinations of ACGIH and other standards considered unsatisfactory by British workers. The Hygiene Standards Committee has expert Sub-Committees, each of which is concerned with a specific standard. There is a sub-committee on asbestos dust in air, one on trichloroethylene vapour and its urinary metabolites, one on airborne vegetable dusts in the textile industry, another on noise criteria for hearing conservation and two new ones are coming into being; on cadmium oxide fume and silica dusts in air.

It is important to take into account the economic consequences of any recommendations made as well as the benefits to health, and this is one reason why on each of these Hygiene Standards Sub-committees, scientific and medical experts from industry are included. The value of a standard rises in proportion to the number of people who become protected by it. A particular advantage of direct industrial representation on hygiene standards committees is that the industry more readily identifies itself with the standards recommended.

The Hygiene Standards Sub-committee on Asbestos, under the Chairmanship of Professor Lane, has developed new hygiene standards for airborne chrysotile dust (LANE *et al.*, 1968). These were based on the results from a medical and environmental study at an asbestos textile factory in England, in which investigations were made on 290 of the men employed at this factory in the period of 1933-1966.

The Sub-committee considered that the degree and nature of the risk associated with the standards should be specified and the method of the derivation of the standard from the data presented should be described in detail. It was also considered that the standards should give prominence to the gradually increasing risk in relation to the concentration rather than to the single figure threshold concept. Open recognition should be given to the possibility that people might be adversely affected, even

*This paper was originally presented at a Conference on Exposure to Asbestos during Brake and Clutch Maintenance, held at Brentwood, Essex, March, 1969.

when the recommended standards of air cleanliness are maintained. It was recognised that to protect the hypersusceptible workers environmental control would have to be supplemented with medical examinations.

It was evident from the data made available to the Sub-committee, and from the earlier American experience, that when concentration is held constant the prevalence of asbestosis was highest among those with the greatest duration of exposure. Over a period of time, dust accumulates in the lungs and gives rise to asbestosis. However, some of the dust is removed from the lungs, for example, by being dissolved. Consequently, if it is assumed that none is removed and exposure is limited accordingly, a safety factor is thereby incorporated. The problem of relating prevalence with concentration and with duration of exposure was resolved by assuming that the cumulative amount of asbestos remaining in the lungs from a given exposure is equally dependent on the dust concentration and on the duration of exposure to that concentration.

The asbestos dust concentration had been measured at the textile factory concerned with several different instruments, including the membrane filter method, in which the number of fibres longer than 5μ was counted. The dust concentration to which different workers had been exposed varied from 1 fibre/cm³ to 27 fibres/cm³ over periods from 10 years to 33 years.

The exposure of an individual was expressed as fibre years/cm³, that is, the product of the average concentration to which he was exposed during working hours and his years of exposure to this average. A curve was developed relating the prevalence of asbestosis to exposure expressed in this way. The principles on which this was based may be explained as follows.

An individual's response to dose of any foreign substance can be expressed by a line (Fig. 1). There is a dose which produces no response whatsoever. This is marked by the threshold A. If the individual is given progressively higher doses, the response progresses correspondingly. The least positive response may be real but merely undesirable. A higher response may have sensory manifestations. A still higher response might be associated with observable physiological changes and overt clinical effects. The highest responses of all would perhaps be signified by loss of consciousness, or even death.

The degree of response may be conceived to be measurable objectively on a continuous scale starting at zero, and the scales of dose and response could be chosen to linearise the relationship between them, as in Fig. 1. The dose-response relationship could then be described by the slope of the line and the point where the line strikes the dose axis. The slope of the line expresses the rapidity with which increases in dose produce increases in response in this individual. The steeper the slope the greater the safety factor necessary in practice to allow for the inevitable occasional excursions of dose above the maximum desirable.

Doses which give zero response are never, in fact, known with absolute certainty since the sensitivity of measurements of response is limited. A response which can just be detected in a man corresponds to another and higher dose, shown as threshold B on Fig. 1. Also, one is not normally considering just one individual. As with all other characteristics of man, the position and slope of a dose-response line varies from one individual to another. Each man's dose-response line is different with a

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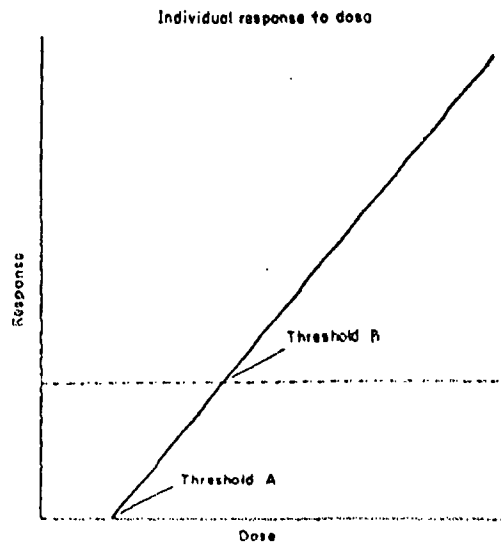


FIG. 1. Individual response to dose.

different threshold dose and a different slope. A particular population under study is represented by a family of dose-response lines centred around the line for the average man.

In a real population the threshold dose will vary from one individual to another about an average value, as in other medical norms. It is to be expected that the size frequency distribution of threshold doses would be a hump-shaped curve tailing away on either side of the central value, as shown in the Fig. 2a.

In a real field study it is established whether a man has or has not been affected. Exactly when or in what concentration he first developed the characteristic response is usually not known. A graph showing exposure against the total number of people affected by it would be a cumulative sigmoid curve, illustrated in Fig. 2b, derived from the size frequency distribution in Fig. 2a. This tails away down to zero response at zero exposure.

An air quality standard is still associated with a small but non-zero probability of men being affected by the contaminant in question. The risk of people being affected can be made as small as one wishes. Zero risk is the ultimate target and an air quality standard has to be a compromise between the costs of bearing a health risk and the costs of air contaminant control.

A curve was fitted to the data from the textile factory on asbestosis, detected clinically and the exposure in fibre years per cm³ of all the individuals under study over their years of employment up to 1966. The bottom end of the fitted curve is shown in Fig. 3. The three points relate to three of the groups of workers studied. The exposure

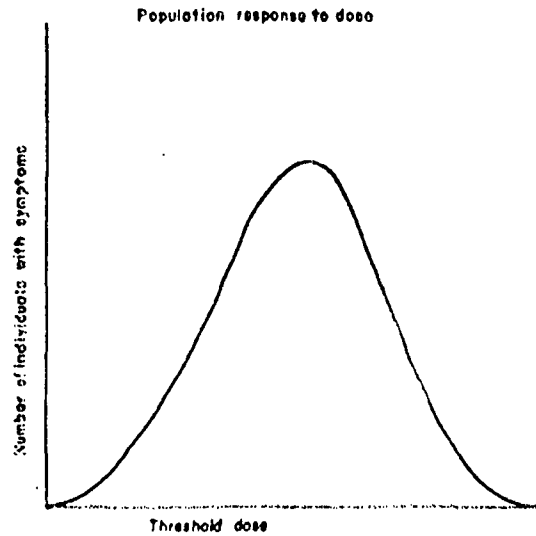


FIG. 2a. Population response to threshold dose.

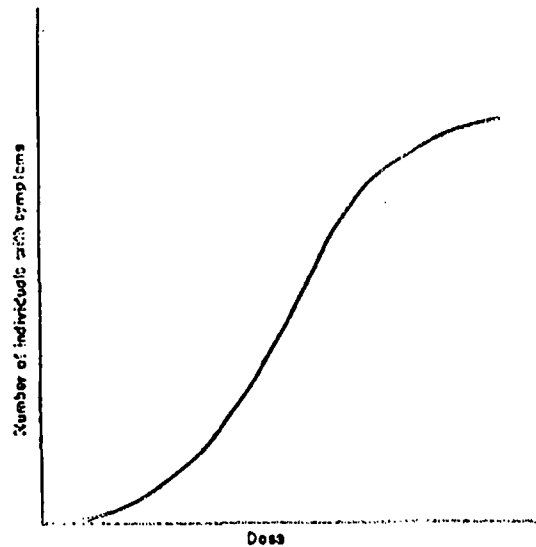


FIG. 2b. Population response to dose.

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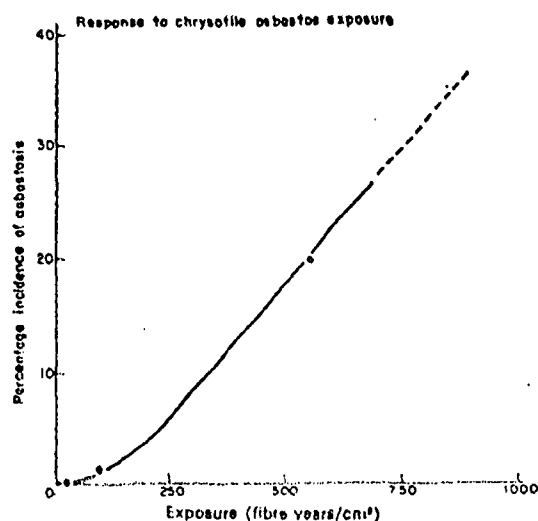


FIG. 3. Response to chrysotile asbestos exposure.

is shown on the horizontal axis, expressed in fibre years per cm^3 and the corresponding prevalence is on the vertical axis, showing the proportion of people with crepitant basal rales.

Basal rales is the earliest clinically demonstrable effect on the lung due to asbestos and there is a steadily increasing prevalence of basal rales with increase in dust exposure. Only groups with near zero dust exposure show zero prevalence of basal rales.

A problem arises when it is appreciated that there is no exposure which can be said to be absolutely free of risk. There is no single threshold exposure held in common by everyone. There is, consequently, this gradually increasing risk in relation to exposure. The application of dust control to meet a TLV, an MAC, MAK value, or other similar hygiene standard will limit and control the risk but is unlikely to reduce it to zero. It has to be remembered that asbestos is very widely used and brings real benefits to the community at large. A standard could be made so stringent that the cost of dust control is prohibitive, that the production and use of asbestos ceases to be economic, production and use is discontinued and the associated benefits are lost. The benefits gained by reducing the risk of asbestosis through reducing air contaminant exposure have to be weighed against the possible loss of direct and indirect benefits to the community from the use of the material.

One conclusion from the exposure-response curve fitted to the data was that for an accumulated exposure of 100 fibre years/ cm^3 , it is probable that the risk of being affected to the extent of having early clinical signs will be less than 1 per cent. That is, for example, a concentration of 2 fibres/ cm^3 for 50 years of such exposure while

at work, 4 fibres/cm³ for 25 years, or 10 fibres/cm³ for 10 years. The British Occupational Hygiene Society Hygiene Standards Sub-committee on Asbestos expressed the view that a proper and reasonable objective would be to reduce exposures to below this level and thereby reduce the risk of contracting asbestosis to less than 1 per cent of those who have a lifetime's exposure to the dust. For such workers, who may possibly work for 50 years, the long term average concentration to which they are exposed would need to be less than 2 fibres/cm³. For others, who will be exposed to asbestos dust in air for shorter periods, the long term average concentration need not be so low, as long as their exposure will amount to less than 100 fibre years/cm³.

The possibility was considered that short periods of very high concentration for a few weeks or less might be disproportionately important in determining the risk of asbestosis. However, the evidence for this was not conclusive and the committee were satisfied that the risk can be satisfactorily expressed with respect to an average concentration over 3 months and can safely be kept below 1 per cent by ensuring that a man's accumulated exposure does not rise above 100 fibre years/cm³.

The exposure measured by making fibre counts on membrane filter samples can be converted into exposure measured with an impinger, the American method, by examining the results of side-by-side comparisons of the two instruments. Such comparisons made by the United States Public Health Service in asbestos textile plants have shown that an accumulated exposure of 100 fibre years/cm³ corresponds to 15 million particle years/ft³ by standard impinger methods (AYER, LYNCH and FANNEY, 1965). The present American Threshold Limit Value is a concentration of 5 million particles/ft³ (mp/ft³) which, if it persisted, would result in an accumulated exposure of 250 million particle years/ft³ over 50 years.

These American hygiene standards, called Threshold Limit Values, are a system for summarising published information on air contaminants in a convenient form for the day-to-day practice of industrial hygiene. The present American standard for 8-hr averages is thus 17 times higher than the British standard for 3 monthly averages. However, there is a published intention to revise the American standard in view of recent knowledge.

However, the difference between the American and British standard is not primarily due to conflicting evidence on the adverse effects of asbestos. It is because of a different attitude now adopted over the degree of protection which ought to be given against asbestosis.

The American Threshold Limit Value of 5 mp/ft³ was recommended by Dreessen and his co-workers in 1938 after studying 541 employees in 4 asbestos textile plants where massive exposures to chrysotile occurred (DREESSEN *et al.*, 1938). Only 3 doubtful cases of pneumoconiosis were found at the time of the study in those exposed to dust concentrations under 5 mp/ft³, whereas numerous well-marked cases were found above 5 mp/ft³.

A conference held in 1965 on the biological effects of asbestos called attention to the very real probability that the 5 mp/ft³ limit recommended by Dreessen is inadequate to give complete working-lifetime protection against all forms of asbestos (SCHALL, 1965). Medical data on which the limits had been based were inadequate; more than half of the asbestos workers studied by Dreessen and his co-workers were under 30 years of age and thus had insufficient exposure time for much asbestosis to

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The standard over 3 months equals 2 fibres; this value and is higher than 2 fibres/cm³ minimum 12 fibres/cm³ compliance. The standards from Inspectorate in judgment on cumulative for even probability that

There is a dusts from man

Correspondence etc
regarding commercial
Drumchere unit

8006 1219

HFM - 005805

June 5, 1978

*Here - Robert
- Bruce Brown*

cc: Mr W. Hombach
Mr N. Gordon

D-M/30K3
1/451

Subject: EXPOSURE TO ASBESTOS DURING BRAKE CLEANING

The Ford of Europe Service department are considering approved equipment for European Dealers including items for the control of the dust produced when brake drums are blown out.

In Ford of Britain there has been some use of items like the Drumolene unit shown on the attached leaflet and we are about to conduct some further tests of their efficiency and of their ability to comply with National legislation.

I should be interested to know whether in Ford of Germany you have legislation which applies to brake-drum cleaning and whether there are any pieces of equipment for dust control which are approved by Government Agencies.

Dr D. L. Hickish

Dr D. L. Hickish
Industrial Hygiene Specialist.
1/163 84-3350.

ENC.

8006 1220

PQ

July 5, 1978

Dr D E Hickish 1/163

cc N R Gordon

Subject: Exposure to Asbestos during Brake Cleaning

A demonstration of the Drumclene brake dust extraction system has been arranged with BT Sales and Services Ltd, the manufacturer of the equipment. It is scheduled for 10.30 on Tuesday, July 11 in the Warley Basement Garage. Please advise the name and extension of the Industrial Hygiene representative who will be attending the meeting.

In addition, we have a prototype equipment from another supplier that can be studied after the Drumclene representative has left.



P J Hinton
European Service
1/451 84:3121

8006 1221

1360

July 17, 1978

cc: Mr P.J. Hinton 1/451
Mr H. Gordon 1/451

Subject: EXPOSURE TO ASBESTOS DUST DURING BRAKE CLEANING

As requested the demonstration of the Drumolene brake dust extraction system by the B.T. Sales engineer was attended on July 11 1978.

While the engineer was demonstrating the cleaning ability of the equipment on the rear brake assembly of a Cortina, a high intensity light beam, as described in the Schedule of the Certificate of Approval No. AP 1 2363 of the Asbestos Regulations 1969, was used to assess the containment of the dust by the equipment. No dust was seen to escape from the equipment during the cleaning, indicating that there should be no hazard to health if this equipment goes into service in the dealerships.

A.J. Crookes
Industrial Hygiene Analyst.

1/163 84-2452

8006 1222 **RQ**



B.T. 'DRUMCLEASE'

MK II

8006 1223

The B.T. 'DRUMCLENE'

With a view to reducing the health hazard from dust and asbestos particles when cleaning out vehicle drum brake assemblies we are proud to offer our range of 'Drumclene' Equipment as illustrated herein.

'Drumclene' enables the effective method of Air Blast Cleaning to be employed in total safety.

The 'Drumclene' is a light-weight steel cylinder, spigot mounted on to a detachable sub-frame which is fitted with fully rotating castors.

The spigot attached to the base of the cylinder is 1½" diameter which enables the 'Drumclene' to be mounted on a standard Trolley Jack for height adjustment if required. Trolley Jack adaptors are available which, when fitted, increase the spigot diameter to 1¾".

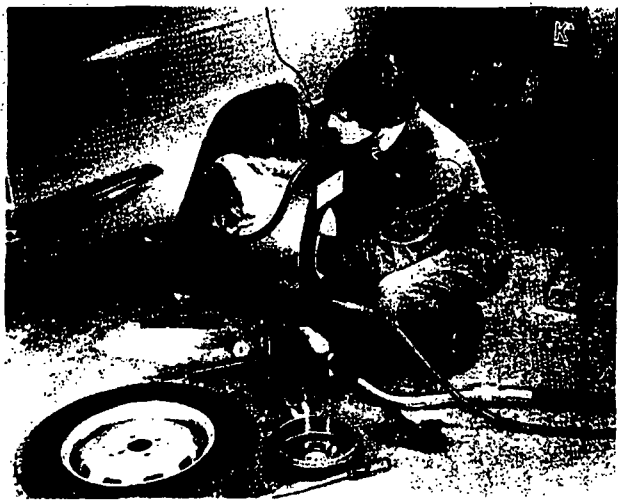
The vehicle end of the 'Drumclene' is partially enclosed by a segmented diaphragm which forms a dust seal behind the backplate of the exposed brake mechanism when the unit is in position.

A fabric sleeve with elastic wrist band enables the operator to handle the press-button air gun inside the unit. Large shatterproof viewing panels are incorporated in both models.

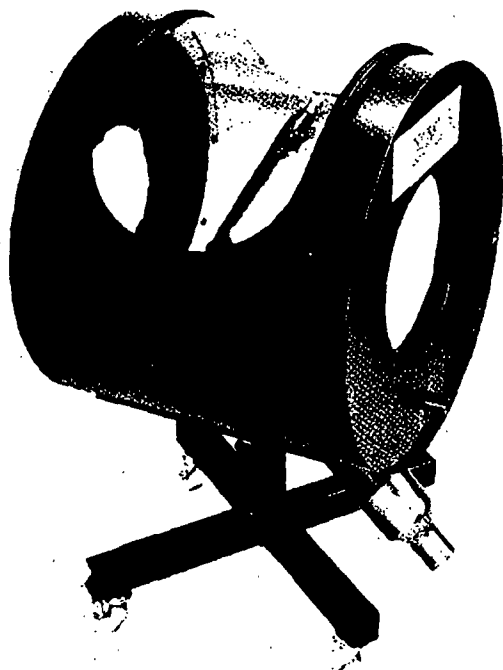
Whilst the unit is complete within itself, it is necessary to connect to a standard air-line supply via the ½" BSP Socket mounted towards the rear end of the unit.

The blast of air on to the exposed brake mechanism within the 'Drumclene' is sufficient to dislodge the majority of dusts, etc., but in extreme cases it may be necessary to dislodge any solidified matter with a stiff brush. All dust and solids are then drawn through the bottom outlet of the unit, which is designed to accept most Industrial Suction Cleaner hoses up to 2½" bore by use of the push-fit reducing adaptor supplied.

Suction Cleaner specifications are noted on the opposite page, but whatever their capacity we recommend the use of a type having bag collection and additional filtration suitable for handling dust and asbestos particles.



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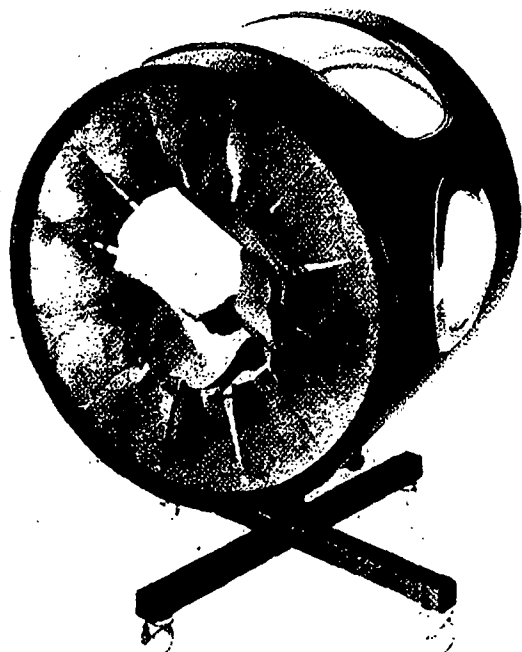
This model is designed to accommodate a wide range of vehicles with drum brakes in the 7" to 12" diameter range.

A single sleeve situated in the rear end of the cylinder enables the operator to complete the cleaning process with efficiency and safety.

In some cases, drum brakes are serviced and cleaned whilst the vehicle is in an elevated position, i.e. on a vehicle lift. In these cases we recommend the use of a high-lift stand (Part No. BT200/175), as illustrated on the opposite page.

Whilst the general requirement of a suction cleaner is outlined in the introductory paragraph it is essential that for use with the BT200 the cleaner must have, in addition to filtration etc., a minimum airflow of 50 CFM with its hose connected.

B.T. 200



Designed for use on the larger diameter drum brakes found on commercial vehicles etc. with back plates in the 12" to 19" diameter range.

Two access sleeves are fitted as standard to this model, but if necessary a third sleeve can be fitted to the centre of the circular rear window. If ordered with this sleeve fitted the model number becomes BT 416.

This third sleeve affords additional access when the 'Drumclene' is used on drum brakes of greater depth than standard, e.g. Double Wheel Assemblies.

In some cases it has been found that Fleet users only handle a specific drum size, for example 17" diameter. In these instances we are able to offer special size diaphragms solely for Fleet use.

It will be appreciated that a suction cleaner for use with the BT400 has to have a larger air-flow than that used on the smaller model, therefore we recommend a cleaner capacity of 95/100 CFM in addition to the filtration requirements mentioned previously.

B.T. 400



8006 1225

Spare Parts List

Description	Spare Part Code Number			
	BT 200	BT 400	BT 200 MKII	BT 400 MKII
Top Window	BT200/101	BT200/101	BT200/120	BT200/120
Sealing Strip, Top Window	—	—	BT200/121	BT200/121
Rear Circular Window	—	BT400/101	—	BT400/125
Sealing Strip, Rear Circular Window	—	—	—	BT400/126
Rear Window, C/W 3rd Sleeve	—	BT400/116	—	BT400/116
Fabric Sleeve	BT200/102	BT200/102	BT200/102	BT200/102
Sleeve Retaining Clip	BT200/103	BT400/103	BT200/103	BT400/103
Castor	BT200/111	BT200/111	BT200/111	BT200/111
Thumb Screw $\frac{5}{16}$ " W	BT200/113	BT200/113	BT200/113	BT200/113
Diaphragm Complete	BT200/115	BT400/115	BT200/115	BT400/115
Air Line Assembly	BT200/108	BT400/108	BT200/108	BT400/108
Outlet Reducer	DG271	DG271	DG271	DG271
Diaphragm Elastic C/W Clip	BT200/105	BT400/105	BT200/105	BT400/105

When ordering spares please quote Description and Part Number



B.T. Sales & Service Limited

Huntingtower Road Sheffield S11 7GR
Telephone 685021 & 661424 (STD 0742)

Agent's Name and Address

8006 1226



TRANSCONTINENTAL SERVICE BULLETIN

No.6Date: 28th March 1978

Circulate to:	Service Manager	Parts Manager	Foreman	Receptionist	Technicians			

Section: 52 Maintenance**Sequence No.** 1**Model:** All Models**SUBJECT:** ASBESTOS**NOTE: ASBESTOS DUST IS DANGEROUS TO HEALTH IF INHALED**

Asbestos dust as found in brake drums/disc brake calipers must not be 'blown-out' with an air line, as it can be injurious to health if inhaled. A vacuum cleaner, brush or rag must be used with care to remove any dust from brake drums or calipers.

Any process, involving the cutting, filing, machining, etc of asbestos materials, must be carried out using suitable extraction equipment, or with the use of personal protective equipment or face mask.

Dust from any of these operations should be collected in a sealed bag for disposal.

Cleaning equipment to suit these conditions can be obtained from

B T Sales and Service Ltd
Huntingtower Road
Sheffield S11 7GR
England

In case of difficulty dealers situated in locations outside the UK may direct enquiries to:

MDA Staines
Overseas Purchasing Service 1/231
Ford Motor Company Ltd
Eagle Way
Warley, Brentwood
Essex CM13 3BW
England

Registered No. in Great Britain 235446 Registered Office, Eagle Way, Brentwood, Essex. CM13 3BW

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Printed in England

8006 1227

Service information
Cars
—

8006 1228



CAR SERVICE LETTER

1968 series

13th NOVEMBER

No.74

EXPOSURE TO ASBESTOS DURING THE SERVICING OF BRAKES

A recent exercise was carried out by the Ford Motor Company Ltd., Medical Services on the above subject. The following is a passage drawn from the conclusion of the report on the exercise;

"On the environmental and analytical evidence obtained it does not appear that a significant hazard to health should occur during brake drum 'blow-out' in a typical dealer passenger car repair shop".

However, it is desirable that inhalation of dust during brake cleaning should be minimised. This could be done by wiping-out brake drums with a clean absorbent cloth free from oil or grease or a cloth lightly impregnated with carbon tetra-chloride (CTC) instead of using an air line to blow-out the drums.

Similarly, care should be taken when blowing out the gearbox bellhousing or clutch disc.

In any event workshop personnel should be advised that in large amounts asbestos dust is injurious to health and its inhalation should be avoided wherever possible.



BY APPOINTMENT TO
HER MAJESTY THE QUEEN
MEMBER OF THE ROYAL
MANUFACTURERS



BY APPOINTMENT TO
HER MAJESTY THE QUEEN
MEMBER OF THE ROYAL
MANUFACTURERS



THE QUEEN'S ARMS
TO MANUFACTURE

SERVICE — CAR DIVISION
FORD MOTOR COMPANY LIMITED, WARLEY, ESSEX.

8006 1229

TECHNICAL SERVICE BULLETIN

CAR AND LIGHT COMMERCIAL

Date 11 NOVEMBER 1977

Circulate to:	Service Manager	Parts Manager	Foreman	Receptionist	Technicians		

Section: 12

Model: Escort '75 onwards with front drum brakes

Subject: WATER INGRESS INTO FRONT DRUM BRAKES

This Bulletin details a rework procedure to be carried out on the front drum brakes of Escort '75 onwards vehicles in any instance of water ingress into the front drum brakes, where there is no obvious reason for water entry, i.e. distorted or damaged brake back plates. The procedure details fitment of a water shield to each front brake back plate.

Service Instructions:

Possible symptoms of water ingress into the front drum brakes are a tendency for brake pull to occur after the vehicle has been driven for an extended period under very wet road conditions.

Vehicles may only be reworked as described below after a check by a senior member of your workshop staff has eliminated all obvious reasons for water ingress.

Rework Procedure:

1. Raise front of vehicle and support on axle stands.
2. Remove front hub cap, wheel and hub and drum assembly from one side of vehicle.
3. Remove brake shoes and retracting springs.
4. Brush dust from back plate and drum.

Note: Never inhale dust from brake linings. Asbestos dust when inhaled can be injurious to health. Do not blow out dust with an airline. A vacuum cleaner, brush or rag should be carefully used to remove any dust. All dust should be contained in a sealed bag for disposal.

5. Position water shield behind back plate by flexing it past the suspension strut, ensuring that it is concentric with the brake back plate. Care must be taken to ensure the brake hose is not damaged. It is essential that the drain slot, which should be 6 mm wide, is at the bottom when the vehicle is on level ground.
6. Clamp water shield in position on back plate.

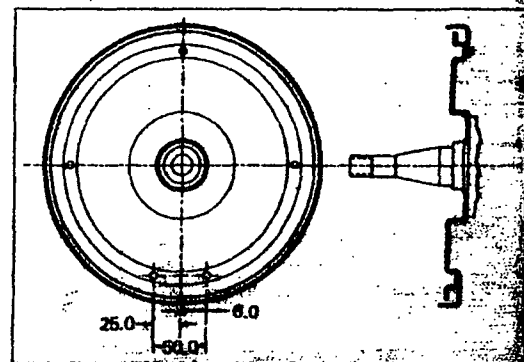


Fig. 1. Installation of water shield
(all dimensions in millimetres)

Continued overleaf



BRAKING SYSTEM

4. Inspect brake discs and pads for signs of wear and damage, Fig. 6.

Brake pads should be renewed if they are below the minimum safe thickness, 3 mm ($\frac{1}{8}$ in.) or if they are the cause of braking problems.

NOTE: Brake pads should always be replaced in sets of four.

5. Replace road wheels.
6. Remove jack, tighten wheel nuts, replace nut caps (where fitted), remove chocks.
7. Press brake pedal firmly once or twice to allow pads to settle in.

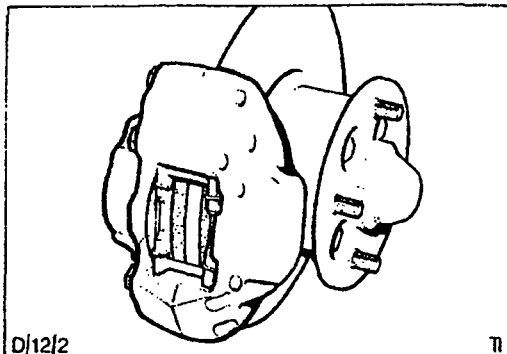


Fig. 6. Disc and Caliper assembly.

Examine rear brake shoes for wear.

1. Remove nut caps (where fitted), loosen wheel nuts, chock front wheels, and jack up rear of car.
2. Remove rear road wheels and brake drums.
3. Check condition of linings.

There should always be at least 1.5 mm (0.060 in.) depth of lining material on bonded linings. In the case of riveted linings, they may be worn down to within 1 mm (0.040 in.) of the rivet heads.

4. Remove any loose dust from drums and linings.

NOTE: **Never** inhale dust from brake linings.

Asbestos dust when inhaled can be injurious to health.

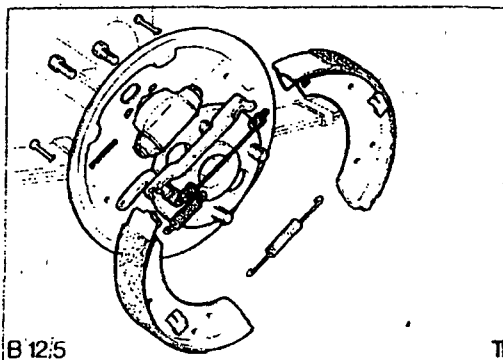


Fig. 7. Rear brake assembly.

8006 1234



BRAKING SYSTEM

Care should be taken if blowing out dust with an airline. Unless eye protection, a respirator, and a well ventilated bay are available, a brush or rag should be carefully used to remove any dust.

5. Examine self-adjusting mechanism and ensure it is operating correctly. If rear brake self-adjust mechanism is not functioning correctly, the cause should be established and dealt with. The brake adjusters should not be adjusted manually.

NOTE: The self adjusters operate off the foot brake, not handbrake mechanism.

6. Refit brake drums and road wheels.
7. Remove jack from car, tighten wheel nuts, replace nut caps (where fitted), and remove chocks from front wheels.

Lubricate handbrake cable linkage at the points shown in Fig. 8.

1. Ensure that traverse rod is well greased where it passes through its retaining brackets.
2. Thoroughly grease all clevis pins using a lithium based (EM-1C-18) grease. Adjust handbrake linkage if necessary.

For the correct adjustment procedure refer to Operation 12 662.

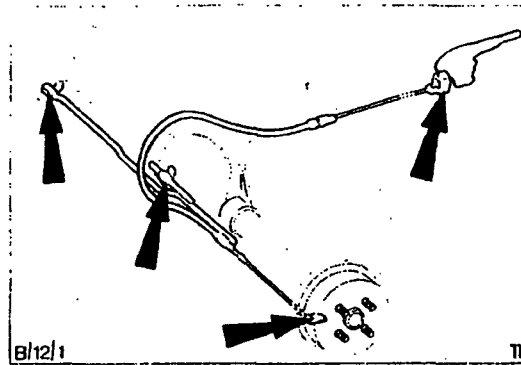


Fig. 8. Handbrake lubrication points.

8006 1232



BRAKING SYSTEM

Examine rear brake shoes for wear.

1. Remove hub caps, loosen wheel nuts, chock front wheels, and jack-up rear of car.
2. Remove rear road wheels and brake drums.
3. Check condition of linings.

There should always be at least 1.5 mm (0.060 in.) depth of lining material on bonded linings. In the case of riveted linings, they may be worn down to the rivet heads.

4. Blow out any loose dust from drums and linings.

NOTE: *Never inhale dust from brake linings.*

Asbestos dust when inhaled can be injurious to health.

Care should also be taken if blowing out dust with an air line. Unless eye protection, a respirator, and a well ventilated bay are available, a brush or rag should be carefully used to remove any dust.

5. Examine self-adjusting mechanism and ensure it is operating correctly, with particular reference to correct handbrake cable adjustment.

If the rear brake self-adjust mechanism is not functioning correctly, the cause should be established and dealt with. The brake adjusters should **not** be adjusted manually to compensate for poor self-adjust operation.

6. Refit brake drums and road wheels.
7. Remove jack from car, tighten wheel nuts, replace hub caps, and remove chocks from front wheels.

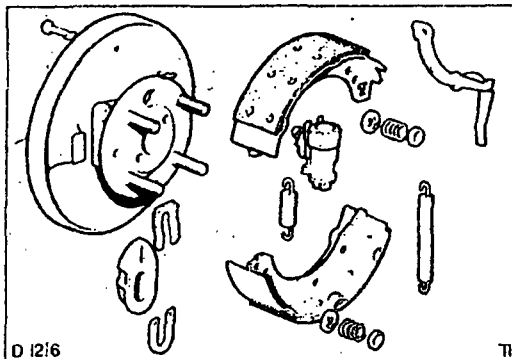


Fig. 6. Rear brake layout.

Lubricate hand-brake cable linkage, Fig. 7.

1. Ensure that longitudinal and transverse cables are well greased where they pass around pulley.
2. Thoroughly grease all clevis pins.

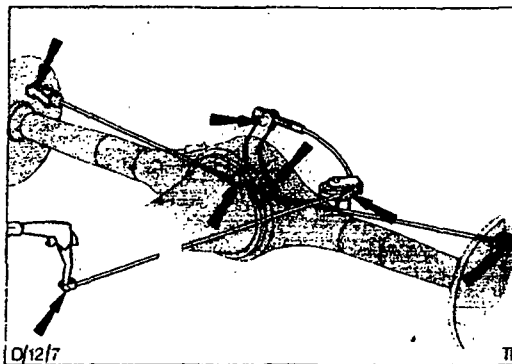


Fig. 7. Handbrake lubrication points.

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BRAKING SYSTEM

Examine rear brake shoes for wear.

1. Remove nut caps (where fitted), loosen wheel nuts, chock front wheels, and jack up rear of vehicle.
2. Remove rear road wheels and brake drums.
3. Check condition of linings.

There should always be at least 1,5 mm (0,060 in) depth of lining material on the linings, 'A', Fig. 6.

4. Remove any loose dust from drums and linings.

NOTE: Never inhale dust from brake linings. Asbestos dust when inhaled can be injurious to health. Do not blow out with an airline. A vacuum cleaner, brush or rag should be used to carefully remove any dust. Any dust should be contained in a sealed bag for disposal.

5. Examine self-adjusting mechanism and ensure it is operating correctly. If rear brake self-adjust mechanism is not functioning correctly, the cause should be established and dealt with. The brake adjusters should not be adjusted manually.
6. Replace brake drums and road wheels.
7. Lower vehicle to ground, remove jack, finally tighten wheel nuts. Replace nut caps (where fitted) and remove chocks from front wheels.

NOTE: Brake pads or shoes should be replaced in sets of four. On no account should only one or a pair of pads or shoes be replaced.

Lubricate and adjust the handbrake mechanism if necessary. Ensure that cable follows its correct run and is correctly located in its guides and all pivot points are lubricated and operating freely, Fig. 8.

For the correct adjustment procedure refer to Operation 12 662.

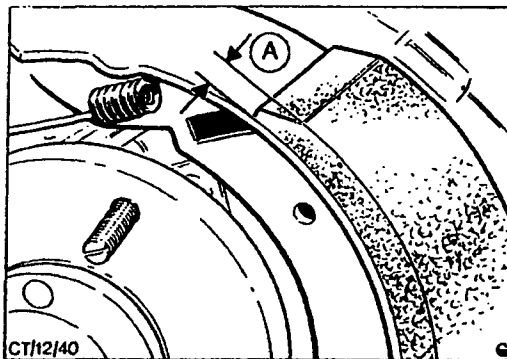


Fig. 6. Brake lining wear.
A - Lining thickness.



Fig. 7. Brake shoes in situ. (Girling 9,0 in shown.)

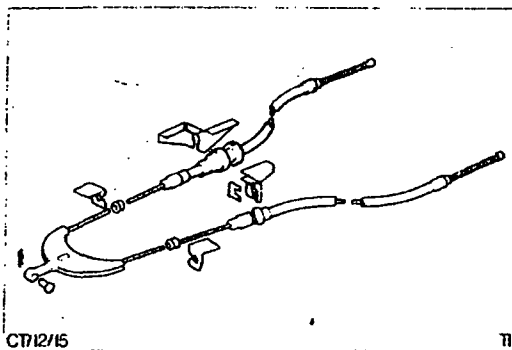


Fig. 8. Handbrake cable assembly.



BRAKING SYSTEM

GENERAL NOTE

Every 80 000 km (36,000 miles) establish the advisability of renewing brake cylinder seals, flexible hoses and hydraulic fluid.

Brake system components must be kept clean of any foreign matter. If necessary any hydraulic components should be washed in clean brake fluid, industrial alcohol or methylated spirits to remove any foreign matter and dried with a clean non-fluffy cloth. Do not use a mineral base fluid such as petrol, paraffin, etc.

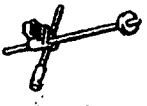
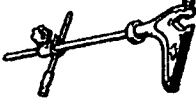
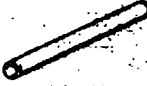
Brake fluid must not be allowed to come into contact with brake pads/shoes or with disc or drum surfaces.

Due to the complexity of braking systems, when renewing or overhauling components, care must be taken to ensure that only correct parts are fitted.

Any brake fluid accidentally spilt onto a painted surface must be cleaned off immediately using cold water to prevent damage to paintwork.

Note: Never inhale dust from brake linings. Asbestos dust when inhaled can be injurious to health. Do not blow out dust with an airline. A vacuum cleaner, brush or rag should be carefully used to remove any dust. Any dust should be contained in a sealed bag for disposal.

SPECIAL SERVICE TOOL RECOGNITION

British Sourced	European Sourced	German Sourced	Tool Name
 P-4008	 15-022	 GV-3311	Dial indicator holding fixture
 SM-891-A	 15-046	 4201	Metric dial indicator gauge
 P-2006			Brake bleeder tube
		 GE-2031	Piston spreader
		 GE-2034	Brake pad remover
	 15-011		Slide hammer
 CP 3072-4A			Adaptor (used with slide hammer)

CT/12/28

September 1976

TAUNUS '76/CORTINA '77 ONWARDS: SECTION 12-5

**Front brake pads and discs**

1. From underneath the vehicle visually inspect brake pads for signs of wear using a suitable mirror, Fig. 15. If thickness is less than 1,5 mm (0,060 in.), renew pads. Refer to Operation 12 233.

Rear brake shoes

1. Remove rubber plug from rear brake carrier plate, Fig. 17. Aperture is adjacent to leading shoe which is subject to faster wear rate than trailing shoe.

2. Visually inspect condition of linings using a lamp. There should always be at least 1,5 mm (0,060 in.) thickness of lining material, Fig. 16.

NOTE: It may be necessary to scrape off paint from edges of brake lining and shoe with the blade of a screwdriver or similar instrument.

3. Replace plug.

At extended service periods, the following maintenance items may be required.

Hydraulic fluid and seals

1. Every 3 years or whenever the disc brake pads are renewed for predominantly Alpine conditions establish the advisability of renewing brake cylinder seals flexible hoses and hydraulic fluid.

Rear brake shoes

1. Loosen rear wheel nuts, chock front wheels and raise rear of vehicle. Fit axle stands.
2. Remove rear road wheels and brake drums.

3. Check condition of linings. There should always be at least 1,5 mm (0 060 in.) depth of lining material on the linings, 'A' Fig. 16.

4. Remove any loose dust from drums and linings.

NOTE: Never inhale dust from brake linings. Asbestos dust when inhaled can be injurious to health. Do not blow out with an airline. A vacuum cleaner, brush or rag should be used to carefully remove any dust. Any dust should be contained in a sealed bag for disposal.

5. Examine self-adjusting mechanism and ensure it is operating correctly. If rear brake self-adjust mechanism is not functioning correctly, the cause should be established and dealt with. The brake adjusters should not be adjusted manually.
6. Replace brake drums and road wheels.
7. Lower vehicle to ground, remove jack, finally tighten wheel nuts, and remove chocks from front wheels.

NOTE: Brake shoes should be replaced in sets of four. On no account should only one or a pair of shoes be replaced.

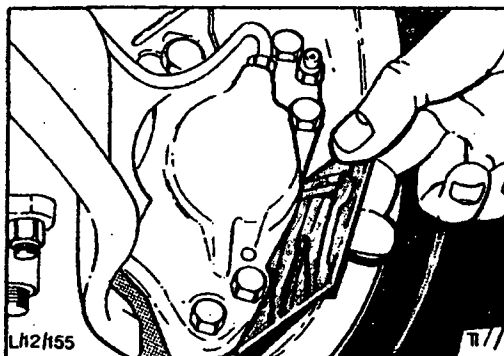


Fig. 15. Checking brake pad wear.

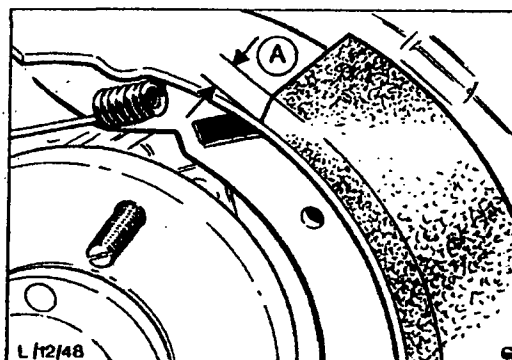


Fig. 16. Rear brake lining wear.

A - Lining thickness.

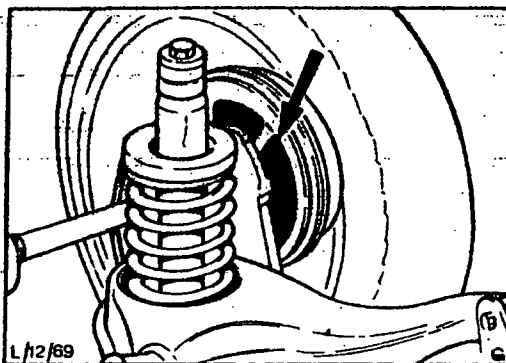


Fig. 17. Rear brake shoe viewing aperture.

12 247 4 PISTONS FRONT CALIPER - REMOVE AND INSTALL (caliper piston housing removed)

SPECIAL SERVICE TOOLS REQUIRED: NONE

To Remove

1. Disconnect flexible hose from chassis end, blank off pipe to prevent excessive fluid loss, and disconnect wear sensor wire from loom. Remove brake pads as described in operation 12-233. Fig.27.
2. Using low hydraulic or air pressure carefully push out piston from cylinder. Position a suitable spacer (wood) between piston and housing to prevent piston from flying out and damaging piston face.
3. Hook out piston seal and dust cover. Wash piston and cylinder bore in commercial alcohol, methylated spirits or approved brake fluid. Ensure pistons and their bores are free from score marks.

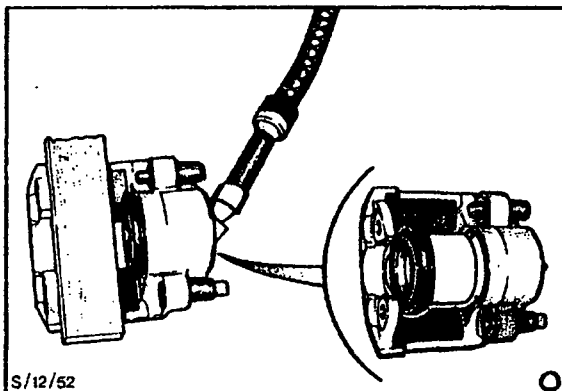


Fig.27. Use low air pressure to push out piston.

To Install

4. Refit piston seal and dust cover into cylinder bore. Stretch dust cover over piston and assemble piston into cylinder bore.
5. Refit brake pads to caliper, refit piston housing to anchor plate, reconnect hydraulic flexible hose. Reconnect pad wear sensor loom.
6. Bleed brakes and check for leaks.

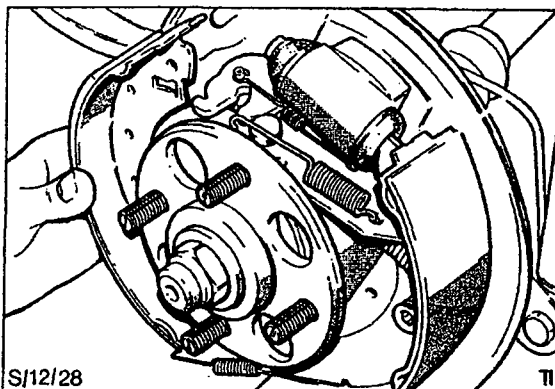


Fig.28. Remove leading shoe.
(left hand brake illustrated)

12 285 SHOES - REAR BRAKE - REMOVE AND INSTALL - ONE SIDE

SPECIAL SERVICE TOOLS REQUIRED: NONE

CAUTION: BRAKE DUST WHEN INHALED CAN BE INJURIOUS TO HEALTH.

To Remove

Left Hand Brake illustrated

1. Remove spring clips securing brake drum to shaft, release handbrake and pull off drum.
2. Remove leading shoe hold down spring and clip, unhook shoe from anchor and wheel cylinder, detach springs and remove shoe. Fig.28.
3. Remove hold down clip and spring from trailing shoe, swing shoe and handbrake lever out to detach cable, Fig.29. Remove self adjuster from shoe.

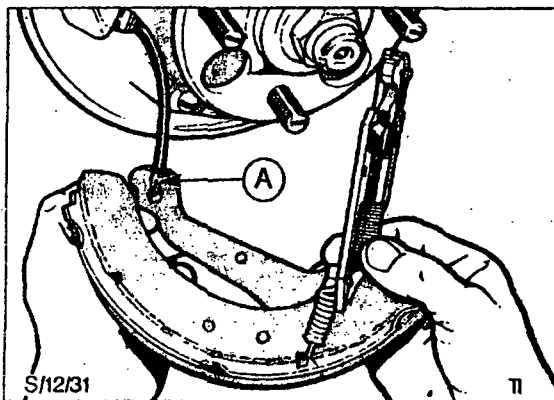


Fig.29. Detach handbrake cable from relay arm.
A - Hand brake cable fixing
(left hand brake illustrated)

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SERVICE ADJUSTMENTS AND CHECKS (cont'd)

The thickness of the pad is indicated by the distance the band is from the bottom of the sliding assembly. When the band is visible past the bottom of the sliding assembly as in Fig.19 'B', then both brake pads require replacing.

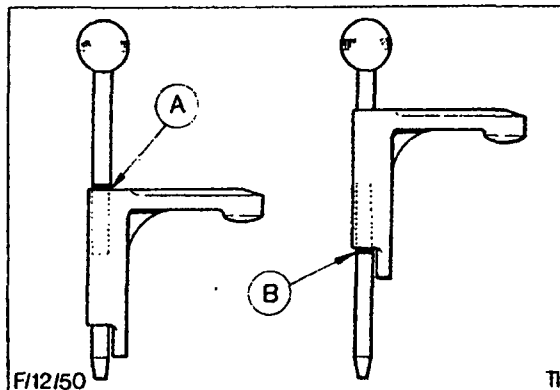


Fig.19. A - Indicating band, showing inner pad requires replacement
B - Indicating band, showing outer pad requires replacement

Examine rear brake shoes for wear.

Remove rubber plug from rear brake carrier, Fig.20. It may be necessary to scrape off a sufficient amount of paint from edge of brake lining and shoe with the blade of a screwdriver or a similar object. Visually inspect condition of linings using a lamp. Replace plug.

There should always be at least 1,0mm (0,040 in) thickness of lining material on the shoe.

The inspection aperture is adjacent to the leading brake shoe which normally wears at a faster rate than the trailing shoe.

NOTE: Never inhale dust from brake linings. Asbestos dust when inhaled can be injurious to health. Do not blow out dust with an airline. A vacuum cleaner, brush or rag should be carefully used to remove any dust. Any dust should be contained in a sealed bag for disposal.

NOTE: Brake pads and shoes should always be replaced in sets of four. On no account should only one or a pair of brake pads or shoes be replaced.

Lubricate handbrake cable linkage at the points shown in Fig.21.

1. Ensure that handbrake cable is well greased where it passes through its retaining guides.
2. Thoroughly grease all clevis pins using a lithium based grease. Adjust handbrake linkage if necessary.
3. Thoroughly grease pivot of equaliser link.

For the correct adjustment procedure refer to Operation 12 662.

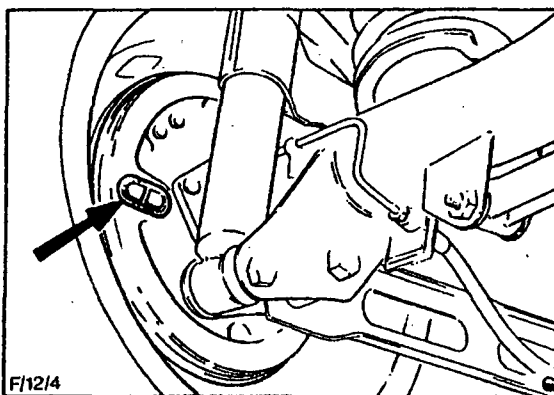


Fig.20. Location of rear brake shoe inspection aperture plug.

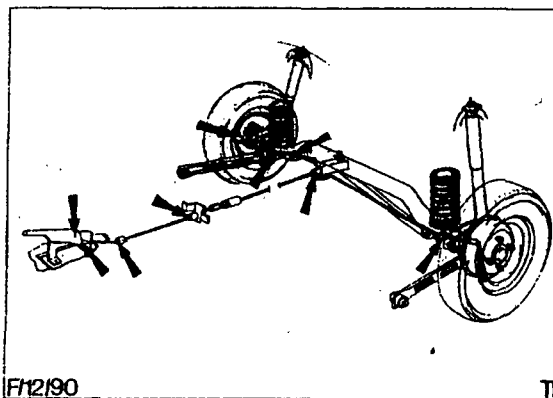


Fig.21. Handbrake lubrication points.

GENERAL NOTE

Every 3 years, establish the advisability of renewing brake cylinder seals, flexible hoses and hydraulic fluid.

Brake fluid is hygroscopic (i.e. absorbs moisture from the atmosphere), and this can reduce its effectiveness to a level that can be significant in severe operating conditions. Therefore, only clean un-used brake fluid from a closed container should be used to top-up the brake master cylinder.

Brake system components must be kept clean of any foreign matter. If necessary any hydraulic components should be washed in clean brake fluid, industrial alcohol or methylated spirits to remove any foreign matter and dried with a clean non-fluffy cloth. Do not use a mineral base fluid such as petrol, paraffin, etc.

Brake fluid must not be allowed to come into contact with brake pads/shoes or with disc or drum surfaces. Due to the complexity of braking systems, when renewing or overhauling components, care must be taken to ensure that only approved parts are fitted.

Any brake fluid accidentally spilt onto a painted surface must be cleaned off immediately using cold water to prevent damage to paintwork.

NOTE: Care should be taken to avoid inhaling dust from brake linings. Asbestos dust when inhaled may be injurious to health. Do not blow out dust with an airline. A vacuum cleaner, brush or rag should be carefully used to remove any dust. Any dust should be contained in a sealed bag for disposal.

SPECIAL SERVICE TOOL RECOGNITION

Tool	Tool Name
 15-022	Dial indicator holding fixture
 15-046	Metric dial indicator gauge
 12-002	Pad wear checking gauge
 GE-2031	Piston spreader*

F/12/62/N

- * This is a proprietary tool available from suppliers such as 'V. Loewener' (under tool number GE-2031) and their agents.

8006 1239

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Front brake pads and discs

1. From underneath the vehicle visually inspect brake pads for signs of wear, Fig.16. If thickness is less than 1,5 mm (0,060 in), renew pads. Refer to Operation 12 233.

Rear brake shoes

1. Remove rubber plug from rear brake carrier plate, Fig.18. Aperture is adjacent to leading shoe which is subject to faster wear rate than trailing shoe.
2. Visually inspect condition of linings using a lamp. There should always be at least 1,0 mm (0,040 in) thickness of lining material, Fig.17.

NOTE: It may be necessary to scrape off paint from edges of brake lining and shoe with the blade of a screwdriver or similar instrument.

3. Refit plug.

At extended service periods, the following maintenance items may be required.

Hydraulic fluid and seals

1. Every 60,000 kms (36,000 miles) establish the advisability of renewing brake cylinder seals flexible hoses and hydraulic fluid.

Rear brake shoes

1. Loosen rear wheel nuts, chock front wheels and raise rear of vehicle. Fit axle stands.
2. Remove rear road wheels and brake drums.
3. Check conditions of linings. There should always be at least 1,0 mm (0,040 in) depth of lining material on the linings, 'A', Fig.16.
4. Remove any loose dust from drums and linings.

NOTE: Never inhale dust from brake linings. Asbestos dust when inhaled can be injurious to health. Do not blow out with an airline. A vacuum cleaner, brush or rag should be used to carefully remove any dust. Any dust should be contained in a sealed bag for disposal.

5. Examine self-adjusting mechanism and ensure it is operating correctly. If rear brake self-adjust mechanism is not functioning correctly, the cause should be established and dealt with. The brake adjusters should not be adjusted manually.
6. Refit brake drums and road wheels.
7. Remove axle stands, lower vehicle to ground, finally tighten wheel nuts, and remove chocks from front wheels.

NOTE: Brake shoes should be replaced in sets of four. On no account should only one or a pair of shoes be replaced.

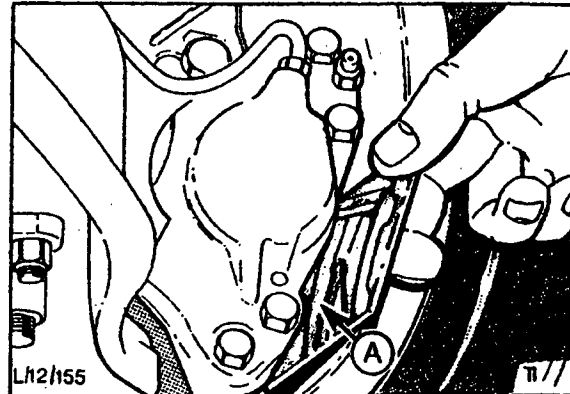


Fig.16. Disc and Caliper assembly.
A - Using a mirror to check pad thickness

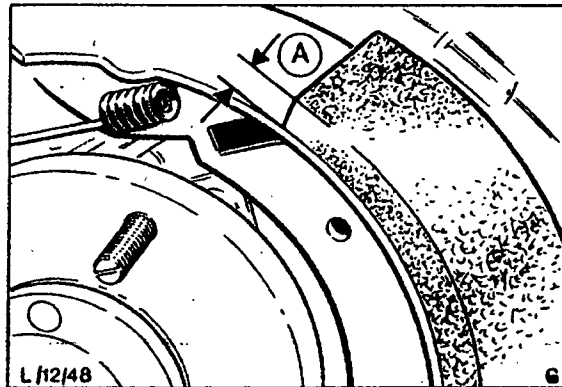


Fig.17. Rear brake lining wear.
A - Lining thickness

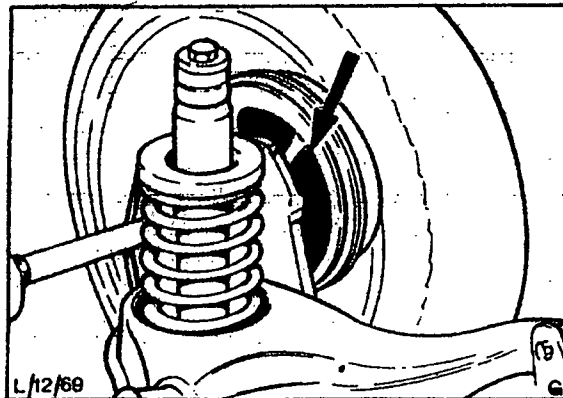


Fig.18. Rear brake shoe viewing aperture

SAFETY PRECAUTIONS CONT'D

- o. In the event that a 'wheel free' lift is not available, and the vehicle is raised using a hydraulic jack, always ensure that:
 - The equipment is in good working order.
 - The jack cradle is correctly and safely positioned.
 - The handbrake is ON or alternatively, the wheels remaining on the ground are 'chocked'

IMPORTANT NOTE: Never raise the front and rear of a vehicle simultaneously with two hydraulic jacks.

Never work on a vehicle supported by a hydraulic jack only, always use axle/body stands positioned correctly.

o. Asbestos dust.

Never inhale dust from brake linings or components. Asbestos dust when inhaled can be injurious to health. Do not blow out dust with an airline. A vacuum cleaner, brush or rag should be carefully used to remove any dust present. Any dust should be contained in a sealed bag for disposal.

o. Brake fluid.

Brake fluid must never be re-used. Brake fluid that has been exposed to the air for a short period of time must not be used. It should be kept in a sealed container at all times. Brake fluid must not be allowed to come into contact with brake pads/shoes or with disc or drum surfaces. Any brake fluid accidentally spilt onto a painted surface must be cleaned off immediately using cold water to prevent damage to the paintwork.

o. Battery acid and connections.

UNDER NO CIRCUMSTANCES ADD ACID TO A CHARGED BATTERY.

- Acid accidentally spilt on skin, clothing or painted surfaces should be removed immediately.

- When reconnecting or using an additional battery as a starting aid, the battery live and earth cables MUST BE CONNECTED CORRECTLY, negative to negative and positive to positive.

o. Thermostatically controlled cooling fan.

NOTE: To ensure safety while working in the vicinity of the cooling fan, the fan motor should be disconnected at the wiring loom multi-plug.

o. Antifreeze.

- Antifreeze must never be taken internally. If antifreeze is swallowed accidentally, medical advice should be sought immediately.

- Precautions should be taken to avoid skin contact with antifreeze. In the event of accidental spillage onto the skin, antifreeze should be washed off as soon as practicable. If clothing is splashed with antifreeze, it should be removed and washed before being worn again, to avoid prolonged skin contact.

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ARC-WELDING - See Welding.

ASBESTOS - See Brake and Clutch Linings and pads.

BATTERY ACIDS - See Acids and Alkalies.

Gases released during charging are explosive. Never use naked flames or allow sparks near charging or recently charged batteries.

BRAKE AND CLUTCH FLUIDS (polyalkylene glycols) - See Fire.

Combustible.

Splashes to the skin and eyes are slightly irritating. Avoid skin and eye contact as far as possible. Inhalation vapour hazards do not arise at ambient temperatures because of the very low vapour pressure.

BRAKE AND CLUTCH LININGS AND PADS - See Legal Aspects.

These items contain asbestos, which if inhaled may cause lung damage and in some cases, cancer.

The normal handling and fitting of these items should not cause any hazard, but any drilling, grinding or filing of friction materials may produce asbestos dust, and should only be carried out under strictly controlled conditions.

The dust in brake drums etc. contains very little asbestos but care should be taken to avoid inhalation of this dust during servicing of brakes and clutches. The use of drum cleaning units, vacuum cleaning or damp wiping is preferred to the use of air jets for "blowing-out".

The dust should be collected in a sealed plastic bag and disposed with according to local laws and regulations.

BRAZING - See Welding.

CHEMICAL MATERIALS - GENERAL - See Legal Aspects.

Chemical materials such as solvents, sealers, adhesives, paints, resin foams, battery acids, antifreezes, brake fluids, oils and grease should always be used with caution and stored and handled with care. They may be toxic, harmful, corrosive, irritant or highly inflammable and give rise to hazardous fumes and dusts.

The effects of excessive exposure to chemicals may be immediate or delayed; briefly experienced or permanent; cumulative; superficial; life threatening; or may reduce life-expectancy.

DO'S

Do remove chemical materials from the skin and clothing as soon as practicable after soiling. Change heavily soiled clothing and have it cleaned.

Do carefully read and observe hazard and precaution warnings given on material containers (labels) and in any accompanying leaflets, posters or other instructions. Material health and safety data sheets can be obtained from Manufacturers.

Do organise work practices and protective clothing to avoid soiling of the skin and eyes; breathing vapours/aerosols/dusts/fumes; inadequate container labelling; fire and explosion hazards.

Do wash before job breaks, before eating, smoking, drinking or using toilet facilities when handling chemical materials.

Do keep work areas clean, uncluttered and free of spills.

Do store according to national and local regulations.

Do keep chemical materials out of the reach of children.

DO NOTS

Do not mix chemical materials except under the manufacturers instructions; some chemicals can form other toxic or harmful chemicals; give off toxic or harmful fumes; be explosive when mixed together.

Do not spray chemical materials, particularly those based on solvents, in confined spaces e.g. when people are inside a vehicle.

Do not apply heat or flame to chemical materials except under the manufacturers' instructions. Some are highly inflammable and some may release toxic or harmful fumes.

Do not leave containers open. Fumes given off can build up to toxic, harmful or explosive concentrations. Some fumes are heavier than air and will accumulate in confined areas, pits etc.

Do not transfer chemical materials to unlabelled containers.

Do not clean hands or clothing with chemical materials. Chemicals, particularly solvents and fuels will dry the skin and may cause irritation with dermatitis. Some can be absorbed through the skin in toxic or harmful quantities.

Do not use emptied containers for other materials except when they have been cleaned under supervised conditions.

ARC-WELDING - See Welding.

ASBESTOS - See Brake and Clutch Linings and pads.

BATTERY ACIDS - See Acids and Alkalies.

Gases released during charging are explosive. Never use naked flames or allow sparks near charging or recently charged batteries.

BRAKE AND CLUTCH FLUIDS (polyalkylene glycols) - See Fire.

Combustible.

Splashes to the skin and eyes are slightly irritating. Avoid skin and eye contact as far as possible. Inhalation vapour hazards do not arise at ambient temperatures because of the very low vapour pressure.

BRAKE AND CLUTCH LININGS AND PADS - See Legal Aspects.

These items contain asbestos, which if inhaled may cause lung damage and in some cases, cancer.

The normal handling and fitting of these items should not cause any hazard, but any drilling, grinding or filing of friction materials may produce asbestos dust, and should only be carried out under strictly controlled conditions.

The dust in brake drums etc. contains very little asbestos but care should be taken to avoid inhalation of this dust during servicing of brakes and clutches. The use of drum cleaning units, vacuum cleaning or damp wiping is preferred to the use of air jets for "blowing-out".

The dust should be collected in a sealed plastic bag and disposed with according to legal laws and regulations.

BRASSING - See Welding.

CHEMICAL MATERIALS - GENERAL - See Legal Aspects.

Chemical materials such as solvents, sealers, adhesives, paints, resin foams, battery acids, antifreezes, brake fluids, oils and grease should always be used with caution and stored and handled with care. They may be toxic, harmful, corrosive, irritant or highly inflammable and give rise to hazardous fumes and dusts.

The effects of excessive exposure to chemicals may be immediate or delayed; briefly experienced or permanent; cumulative; superficial; life threatening; or may reduce life-expectancy.

DO'S

Do remove chemical materials from the skin and clothing as soon as practicable after soiling. Change heavily soiled clothing and have it cleaned.

Do carefully read and observe hazard and precaution warnings given on material containers (labels) and in any accompanying leaflets, posters or other instructions. Material health and safety data sheets can be obtained from Manufacturers.

Do organise work practices and protective clothing to avoid soiling of the skin and eyes; breathing vapours/aerosols/dusts/fumes; inadequate container labelling; fire and explosion hazards.

Do wash before job breaks, before eating, smoking, drinking or using toilet facilities when handling chemical materials.

Do keep work areas clean, uncluttered and free of spills.

Do store according to national and local regulations.

Do keep chemical materials out of the reach of children.

DO NOTS

Do not mix chemical materials except under the manufacturers instructions; some chemicals can form other toxic or harmful chemicals; give off toxic or harmful fumes; be explosive when mixed together.

Do not spray chemical materials, particularly those based on solvents, in confined spaces e.g. when people are inside a vehicle.

Do not apply heat or flame to chemical materials except under the manufacturers' instructions. Some are highly inflammable and some may release toxic or harmful fumes.

Do not leave containers open. Fumes given off can build up to toxic, harmful or explosive concentrations. Some fumes are heavier than air and will accumulate in confined areas, pits etc.

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SAFETY PRECAUTIONS CONT'D

- In the event that a lift/hoist is not available, and the vehicle is raised using a jack, always ensure that:
 - The equipment is in good working order.
 - The jack cradle is correctly and safely positioned.
 - The handbrake is fully on or alternatively, the wheels remaining on the ground are 'chocked'.

IMPORTANT NOTE: Never raise the front and rear of a vehicle simultaneously with two jacks and never work on a vehicle supported by a jack only, always use axle/body stands positioned correctly.

Asbestos dust:

Never inhale dust from brake linings or components. Asbestos dust when inhaled can be injurious to health. Do not blow out dust with an airline. A vacuum cleaner, brush or rag should be carefully used to remove any dust present.

Any dust extracted should be contained in a sealed bag for disposal.

Brake fluid:

Brake fluid must never be re-used. Brake fluid that has been exposed to the air for a short period of time must not be used. It should be kept in a sealed container at all times. Brake fluid must not be allowed to come into contact with brake pads/shoes or with disc or drum surfaces. Any brake fluid accidentally spilt onto a painted surface must be cleaned off immediately using cold water to prevent damage to the paintwork.

Battery acid and connections:

UNDER NO CIRCUMSTANCES ADD ACID TO A CHARGED BATTERY.

- Acid accidentally spilt on skin, clothing or painted surfaces should be removed immediately using water.
- When reconnecting or using an additional battery as a starting aid, the battery live and earth cables **MUST BE CONNECTED CORRECTLY**, negative to negative and positive to positive.

Compressed air:

Compressed air jets must never be aimed, either directly or indirectly at a person.

Under no circumstances should compressed air be used to:

- Dry hands.
- Clean overalls.
- Remove dust from brake or clutch components.

Antifreeze:

- Antifreeze contains Monoethylene Glycol and other constituents which are toxic if taken internally and can be absorbed in toxic amounts on repeated or prolonged skin contact.
- Precautions should be taken to avoid skin contact with antifreeze. In the event of accidental spillage onto the skin, antifreeze should be washed off as soon as possible with clean water.

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Service information
Trucks

8006 1247

January 10, 1984

Dr. D. Hickish 1/163

Subject : Reference to Asbestos in Service Publications

Further to our telephone conversation, enclosed please find copies of all references to asbestos dust contained in Truck (i.e. A-Series Upwards) Workshop Manuals. Specifically, the extracts are from the following publications:-

1. Cargo Workshop Manual
2. D-Series Workshop Manual - 1979 onward
3. D-Series Workshop Manual - pre 1979
4. Transcontinental Manual (Updated version of Jan '83)
5. A-Series Workshop Manual - 1979 onward
6. A-Series Workshop Manual - pre 1979
7. Technical Service Bulletin No 3 - 1977 Series
8. R-Series Workshop Manual (1970 edition)
9. 1978 R-Series Workshop Manual

Please let me know if you require any further information.

M.R. Noble

M.R. Noble
Supervisor - Technical Service
Truck Service
40/537 : Brentwood : 216849

*Also Transcontinental Bulletin No 6
March 1978.*

8006 1248



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HEALTH AND SAFETY PRECAUTIONS 05

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Do not clean hands or clothing with chemical materials. Chemicals, particularly solvents and fuels will dry the skin and may cause irritation with dermatitis. Some can be absorbed.

July 1981 Page 3

8006 1249

PQ

12 BRAKING SYSTEM

REPAIR PROCEDURES

SERVICING OF BRAKE SYSTEM COMPONENTS. General Notes

Cleanliness

☐ Before any brake component is removed or dismantled, the component and surrounding area should be cleaned to prevent dirt ingress.

☐ All gasket mating surfaces should be thoroughly cleaned to receive a new gasket. Gasket or gasket faces should not be coated with a sealant unless specified.

☐ Brake valve components should be washed in a suitable cleaning solvent and blown dry with compressed air.

Checking for Wear and Damage

☐ When overhauling a brake component the working parts and surfaces must be checked for wear and damage, and sizes checked with specifications.

☐ Pistons and bores must be checked for scores, pitting and corrosion caused by abrasion or water particles.

☐ Diaphragms must be checked for wear, damage, cracks and perforations.

☐ Worn or damaged parts should be renewed with FORD Service or Motorcraft replacement parts.

Lubrication of Brake Component Moving Parts

☐ All brake component metal contact surfaces such as brake shoe tips, tappet heads, steady posts, etc. should be lubricated with the specified grease. This ensures free movement of the components and assists in preventing brake squeal. Do not use excessive grease where there is a possibility that the brake linings could become contaminated.

☐ All the moving parts within brake valves should be lubricated using only the recommended specified grease or lubricant. It is important that incorrect lubricants are not used as this can cause contamination and possible seizure of valve components.

HYDRAULIC COMPONENTS

Pipe Removal

Suitable pipe plugs should always be fitted to hydraulic pipe unions and their associated components when the pipe is disconnected to minimise fluid loss and prevent dirt ingress.

Wheel Cylinder Piston Retainers

Suitable wheel cylinder piston retainers should be fitted when brake shoes are removed to prevent the pistons emerging, which causes hydraulic fluid loss, piston seal damage and unnecessary brake bleeding.

Assembly

When assembling a hydraulic component, pistons, seals and bores etc. they should be lubricated in clean, specified hydraulic fluid.

Care should be taken when assembling hydraulic seals to ensure that the seal lips are facing the hydraulic pressure. Do not damage the seals when assembling them onto the piston or inserting them into the bores.

GLAZED BRAKE LININGS

Brake linings which have become glazed lose their efficiency. This condition is brought about by the linings rubbing lightly against the brake drum surface causing the bonding resins in the lining material to become highly polished. The fault may be caused by a partially seized wheel cylinder or expander, or even repeated very light applications of the brakes.

In order to restore brake efficiency this glazed surface must be removed.

De-Glazing

WARNING: Asbestos protection equipment must be worn throughout the following operation.

With the brake drums removed, the shoe lining surface can be restored to its original condition by removing the polished bonding resin. Wrap a 50 mm (2.0 in) wide strip of 80 coarse grade emery cloth, sufficient to cover the entire length around the lining arc and move it backwards and forwards until the whole surface has been restored.

12 BRAKING SYSTEM

☐ Tie the wheel cylinder pistons in position—use a rubber band, string, or soft wire.

☐ Disconnect the return springs from the brake shoes.

Cleaning and Inspection

Clean the brake shoes, drum and backplate assembly by cleaning where possible. Use vacuum extraction equipment to remove the brake shoe dust which may contain asbestos. Use solvents only where it is necessary to remove oil or grease contamination. Do NOT allow solvents, oil or grease to contaminate the brake linings.

Examine the brake shoes, linings and return springs for damage and wear. Renew or refit the brake shoes if the lining material is contaminated, damaged or worn down to almost the level of the rivet heads.

Examine the brake drums for excessive wear, damage, ovality and taper. Renew or repair the drums as necessary.

CAUTION: ALWAYS renew brake shoes or linings if they show uneven wear. If a shoe is worn at one end and is replaced by a new shoe, the other shoe must also be renewed.

oversize and an axle set of oversize linings fitted.

Examine the wheel cylinders for leaks or damage and renew or overhaul them as necessary.

Examine the snail cam adjuster (manual adjuster brakes only) for wear, damage and security in the backplate. Overhaul if necessary.

Examine the backplate and grease baffle for damage, tightness of mounting bolts to the hub flange, security of the brake shoe steady posts and excessive corrosion.

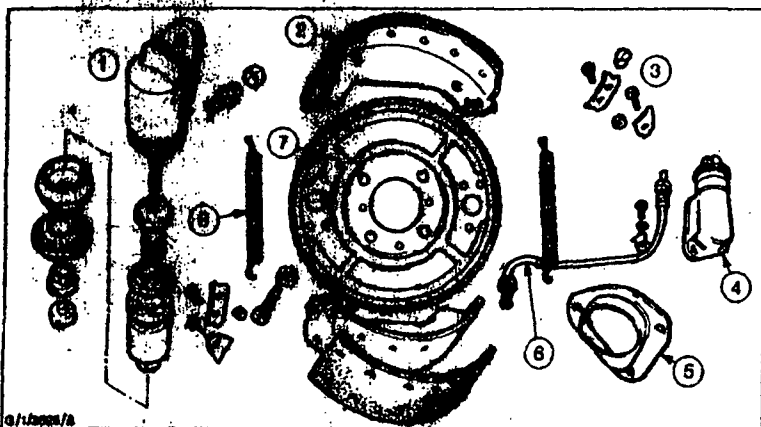
Wheel Cylinder - Removal

☐ Disconnect the hydraulic feed pipes from the wheel cylinders and blank off the open ends.

NOTE: Vehicles with 'V' split hydraulic systems have a single feed to each wheel and a bridge pipe connecting the upper and lower cylinders.

Vehicles with 'L' split hydraulic systems have a separate feed to each wheel cylinder.

☐ Straighten the lock tabs and remove the bolts securing each wheel cylinder to the brake backplate. Remove the wheel cylinder.



Q/1/2/3/4

HLD6 Auto-Adjuster Rear Brake Assembly

1. Wheel Cylinder Assembly

2. Shoe Assembly

3. Wheel Cylinder Mounting Bolts

4. Wheel Cylinder

5. Grease Baffle

6. Bridge Pipe

7. Backplate

8. Return Spring

12 BRAKING SYSTEM

☐ Make a note of the position and colour of the brake shoe return springs. Remove the springs, using Special Tool No. 64927026, and remove the brake shoe and parking brake lever assemblies.

NOTE: The brake shoe return springs must be renewed at brake reline/overhaul intervals. Discard the old springs.

☐ Secure the wheel cylinder pistons with string or a rubber band.

☐ Separate the parking brake levers from the shoes.

☐ Slacken the lock screws and remove the thrust pad height adjusters from the parking brake levers.

☐ Remove the auto-adjust stop plate and remove both auto-adjust assemblies.

Cleaning and Inspection

Clean the brake shoes, drum and backplate assembly, dry cleaning where possible. Use vacuum extraction equipment to remove the brake shoe dust which may contain asbestos particles. Use solvents only where it is necessary to remove oil or grease

contamination. Do **NOT** allow solvents, oil or grease to contaminate the brake linings. Examine the brake shoes, linings and parking lever return springs for damage or wear. Renew or reline the brake shoes if the lining material is contaminated, damaged or worn down to almost the level of the rivet heads.

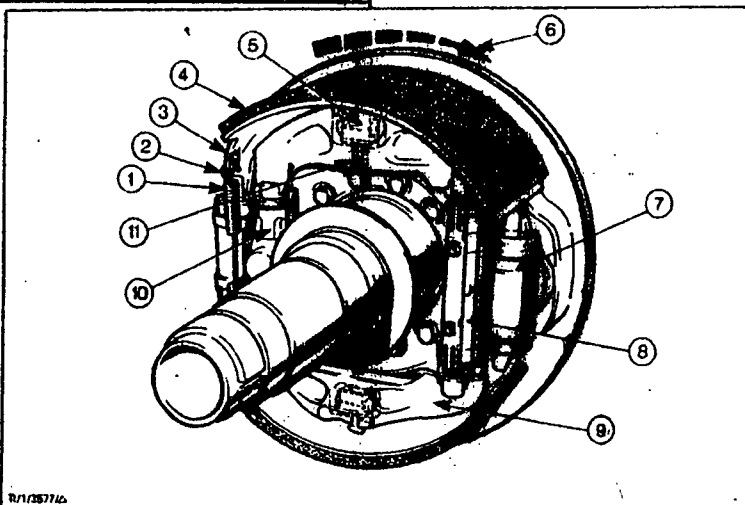
Examine the brake drums for excessive wear, damage, ovality and taper. Renew or repair the drums as necessary.

CAUTION: ALWAYS repair brake shoes or linings in axle sets to avoid uneven braking. If a brake drum is damaged and is repaired by skimming out to oversize, then the other drum of the axle set **MUST** also be made oversize and an axle set of oversize linings fitted.

Examine the wheel cylinders for leaks or damage and renew or overhaul them as necessary.

Examine the adjuster assembly for wear, damage and for correct operation. Overhaul as necessary.

Examine the expander assembly for wear, damage and security to the backplate. Overhaul if necessary.



H2LS Rear Brake Assembly - Auto Adjust Shown

1. Return Spring

2. Spring Eye

3. Spring Locating Hole

4. Shoe Assembly

5. Thrust Pad

6. Direction of Forward Rotation

7. Wheel Cylinder

8. Adjuster Housing

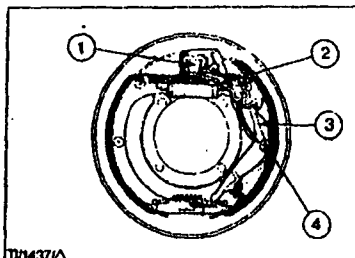
9. Parking Brake Lever

10. Parking Brake Expander

11. Thrust Pad Height

Adjuster Screw

12 BRAKING SYSTEM



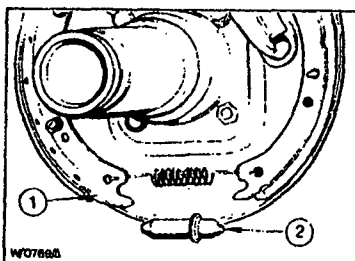
TV1437/A

Remove the Auto-Adjust Link

1. Anchor Plate
2. Link
3. Actuating Lever
4. Hold Down Spring Assembly

Brake Shoe Removal

☐ Remove the rear brake shoe pull-off spring, completely slacken the brake adjuster, expand the lower brake shoe tips and remove the adjuster assembly.



Removing the Adjuster

1. Brake Shoes Expanded
2. Serrated Adjuster

- ☐ Remove the split pin and the parking brake cam retaining nut.
- ☐ Remove the auto-adjust link anchor plate and the parking brake cam from the cam shaft and cable.
- ☐ Remove the three remaining brake shoe hold down spring assemblies and the lower brake shoe return spring.
- ☐ Remove the brake shoes and upper return spring and disconnect the upper brake shoe return spring from the brake shoes.

Cleaning and Inspection

Clean the brake shoes, drum and backplate assembly, dry cleaning where possible. Use

vacuum extraction equipment to remove the brake shoe dust which may contain asbestos particles. Use solvents only where it is necessary to remove oil or grease contamination. Do NOT allow solvents, oil or grease to contaminate the brake linings.

Examine the brake shoes, linings and return springs for damage and wear. Renew or reline the brake shoes if the lining material is contaminated, damaged or worn down to almost the level of the rivet heads.

Examine the brake drums for excessive wear, damage, ovality and taper. Renew or repair the drums as necessary.

CAUTION: ALWAYS renew brake shoes or linings in axle sets to avoid uneven braking. If a brake drum is damaged and is repaired by skimming out to oversize, then the other drum of the axle set MUST also be made oversize and an axle set of oversize linings fitted.

Examine the wheel cylinder for leaks or damage and renew or overhaul it as necessary.

Examine the adjuster mechanism for wear, damage and corrosion. Renew parts as necessary.

Examine the parking brake mechanism for wear, damage or corrosion. Renew parts as necessary.

Examine the backplate and grease baffle for damage, tightness of mounting bolts to the hub flange, security of the brake shoe steady posts and excessive corrosion.

The carrier plate retaining nuts must be checked by tightening them to the specified torque. If the nuts move during this check, they must be removed and discarded and new self locking nuts fitted and tightened to the specified torque after cleaning and applying the specified loctite to the threads of the retaining bolts.

Parking Brake Cross Cable Removal

- ☐ Slacken the cross cable clevis lock nut, remove the clevis split pin and disconnect the clevis from the parking brake equaliser. Remove the clevis and locknut from the cable.
- ☐ Remove the split pin and clevis pin retaining the cable quadrant to the back plate bracket and remove the quadrant and cable assembly. Remove the cable rubber boot from the backplate.

All Engines

- Remove the two clutch slave cylinder retaining bolts and secure it clear of the clutch housing. Remove the clutch release arm gaiter and push rod.
- Remove the clutch housing retaining bolts and the negative battery cable stud. Remove the housing from the engine and lift out the clutch release bearing hub and arm.
- Remove the bolts retaining the pressure plate and cover assembly to the flywheel and withdraw the assembly and clutch disc.

Renew the release arm and pivot assembly if the arm is damaged or if the pivot is loose.

If the clutch disc/flywheel face exhibits signs of uneven wear or a vibration has been repeated, check the flywheel face run out as detailed in Section 21.

NOTE: If any clutch component is worn or damaged, the complete pressure plate cover assembly and disc should be renewed, including the release bearing.

Examine and where necessary, renew the pilot bearing in the flywheel as described in this section.

Cleaning and Inspection

⚠ WARNING: Clutch disc linings contain particles of asbestos which is dangerous to health if inhaled. Do not 'blow-out' dust from clutch assemblies with compressed air. Wherever possible, use a vacuum cleaner and/or carefully collect the dust in a container which must then be sealed for disposal.

Thoroughly clean the clutch housing, release bearing, arm, flywheel face and the engine mountings and half cups.

Check the flywheel face, clutch pressure plate assembly, release bearing/hub assembly and the release arm/pivot assembly for wear and damage.

NOTE: It is not necessary to renew the release bearing hub if either or both the small rear lugs are broken as they only serve a production facility.

V6/V8 Engines Only: Inspect the release bearing grease tube for wear or damage. Apply the specified grease to the nipple to check that the tube is not blocked.

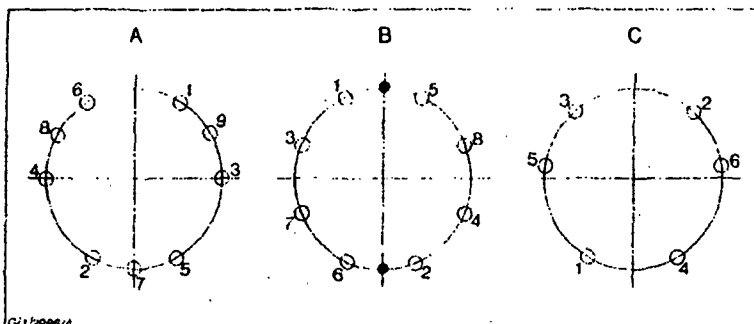
Installation

- Position the disc and cover assembly to the flywheel and loosely fit the cover retaining bolts.

CAUTION 1: Where an 8 speed transmission is used with a 6 cylinder in-line engine, ensure the clutch disc is of the reinforced steel backed type. This can be identified by a white paint spot on the transmission side of the clutch disc hub.

CAUTION 2: Ensure the disc is fitted correctly e.g. named face to flywheel or shallowest projecting side of splined boss towards flywheel.

- Using a universal clutch aligning tool, locate the clutch disc in position and tighten the retaining bolts in the



G11/298/4

Clutch Tightening Sequence (○ = Clutch Retaining Bolts ● = Dowels)

A. Deutz Perkins and Cummins 504

B. 6 Cylinder In-Line Engines

C. 4 Cylinder Engines

SERVICE AND REPAIR OPERATIONS

General Precautions

Before commencing any repairs or adjustments that involve tilting the axle the correct tilting procedure, described in section 14, must be strictly adhered to.

WARNING: It is dangerous not to follow the correct procedure.

Brake Assemblies

Brake shoes must only be changed in complete axle sets. Do not replace shoes on one side of an axle as this may cause unequal braking and result in a dangerous condition on the road.

Extreme care should be taken when removing the brake shoes to avoid damage to the wheel cylinders, rubber boots or dust covers.

Before installing brake assemblies clean the back plate and lightly lubricate, with high melting point grease, the steady pins, anchor or fulcrum pins, operating levers, thrust pads and the abutment edges of shoes.

Hydraulic Components

Before disconnecting or removing any hydraulic pipe or component the area around the connections affected should be thoroughly cleaned and, once such a disconnection is made, the exposed pipe end and connecting point must immediately be suitably sealed against the entry of dirt into the system.

Before reassembly all hydraulic brake parts should be washed thoroughly in commercial alcohol, methylated spirit or approved brake fluid to ensure that all foreign matter is removed.

CAUTION: Any foreign matter which finds its way into the hydraulic system may score the pistons or damage the seals and render the brakes either partly or even wholly inoperative.

Do not use petrol, paraffin, carbon tetrachloride or any other mineral oil solvent for cleaning any part of the hydraulic system. The slightest trace of such fluids can soon render the brakes inoperative by causing swelling and deterioration of the rubber seals.

Commercial alcohol or methylated spirit must always be used when flushing out the system, washing brake assemblies or their components and any container used for holding brake fluid.

All cylinders, pistons and piston seals should be protected from grease, oil and dirt during storage and all such parts, whether they are used or new and just drawn from stock, must be carefully examined before fitting.

When inspecting seals they must not be turned inside out as this would strain the surface skin of the rubber and lead to premature failure in service. The acceptance requirements are that the sealing lips are perfectly formed, concentric with the bore of the seal and free from knife edges, surface cracks, blemishes or other irregularities.

When inspecting cylinders and pistons the acceptance requirements are that they must be free from scores, ridges, steps, sharp edges, burrs or any other imperfections in or on their working or mating surfaces.

CAUTION: Any irregularity, however minute, in the seals, pistons or cylinders may form a track for fluid leakage under pressure and render the brakes inoperative. Therefore any part found to contain a visible imperfection must be rejected. It is also important that all parts are handled very carefully at all times, particularly after examination, to reduce the possibility of causing accidental scoring or other damage.

Before assembling hydraulic components always immerse them in clean approved brake fluid to ease their fitting and to provide initial lubrication for the working surfaces.

After completing any operation which involves the disconnection or replacement of any hydraulic component, the hydraulic system must be bled as described in operation 12 141.

Asbestos

WARNING: ASBESTOS DUST IS DANGEROUS TO HEALTH IF INHALED. Because of the injurious nature of asbestos dust as found in brake drums it must not be 'blown-out' with an air line. A vacuum cleaner, brush or rag must be used with care to remove any dust from brake drums. Any process which involves such requirements as cutting, filing or machining of asbestos materials must be carried out using suitable extraction equipment or with the use of a face mask or other similar personal protective equipment. Dust from any such operation should be collected in a sealed bag for disposal.

Cleaning equipment to suit these conditions can be obtained from:—

B. T. Sales and Service Ltd.
Huntingtower Road,
Sheffield S11 7GR
England.

79 D-SERIES

8006 1255

PQ

17. Bleed the rear wheel brake assemblies as follows:
 - (a) ensure that the brake fluid reservoirs are full to the correct level
 - (b) remove any dust cap from the bleed valve on the rear wheel brake cylinders.
 - (c) use the same procedure as for the front brake assemblies.
18. Bleed the brake fluid reaction valve as follows:
 - (a) ensure that the brake fluid reservoirs are full to the correct level
 - (b) remove any dust caps from the reaction valve bleed valves
 - (c) connect the bleed tube onto the reaction valve bleed valve
 - (d) continue with the same procedure as for the front brake assemblies.

To Install

NOTE: Ensure that the brake shoe lining material of the replacement shoes is correct (see specifications). Check the code on the side of the brake shoe lining.

9. Fit the brake shoe return spring to both brake shoes.
10. Locate the leading end of the uppermost brake shoe into the wheel brake cylinder piston and its trailing end in the abutment.
11. Using the brake shoe horn (Tool No. 64947016) carefully lever the leading end of the other brake shoe into the wheel brake cylinder piston and then lever the trailing end of the brake shoe into the abutment slot in the other cylinder.
12. Ensure that the brake shoes are central and refit the wheel, hub and drum assembly as described in operation 14 263.

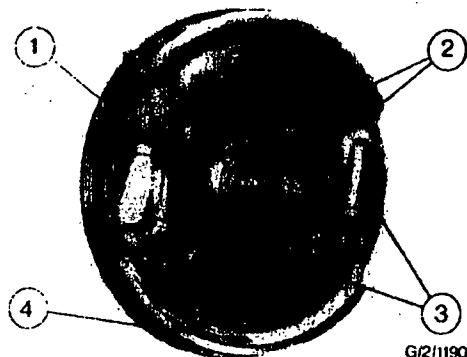
12 283 SHOES — FRONT BRAKE — REMOVE AND INSTALL (ONE SIDE) (INCLUDES ADJUST BOTH SIDES)

WARNING: When the brake drums are removed there is a certain quantity of dust around the brake shoes and inside the brake drums. This dust contains asbestos and is dangerous if inhaled. Care must be exercised in the removal of this dust. Do NOT use an air line to blow away the dust. Use a vacuum cleaner. If a vacuum cleaner is not available use protective breathing equipment and remove the dust with a brush or rag. Collect the dust in a sealable plastic bag for disposal.

HLS/S TYPE FRONT BRAKE ASSEMBLY

To Remove

1. Ensure that the parking brake has been applied.
2. Place a jack under the centre of the front axle and raise the vehicle to enable axle stands to be placed under each end of the axle.
3. Lower the jack until it just supports the axle.
4. Using a wheel trolley, remove the wheel, hub and drum assembly as described in operation 14 363.
5. Prise one of the brake shoes from its abutment on the wheel brake cylinder using brake shoe horn tool (Tool No. 64947016).
6. Gradually release the brake shoe so that the other brake shoe can also be removed.
7. Remove both the brake shoes together with their brake shoe return springs.
8. Disconnect the brake shoe return springs from the brake shoes (see illustrations).



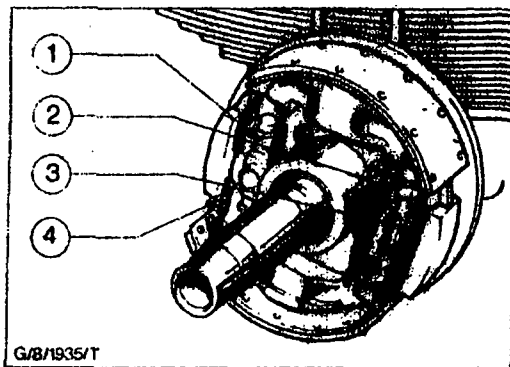
HLS/S Front Brake Assembly

- | | |
|------------------------|--------------------|
| 1. Brake Shoe Adjuster | 3. Wheel Cylinders |
| 2. Return Spring | 4. Brake Shoe |

13. Slacken-off the brake shoe steady post locknuts using the special adjuster tool (Tool No. 64927025). Unscrew each steady post by two full turns.
14. Turn the wheel brake adjusters in a clockwise direction until the brake shoes lock the brake drum.
15. Screw in one brake shoe steady post until it contacts the brake shoe web, and tighten the locknut using the special adjuster tool (Tool No. 64927025).
16. Repeat the adjustment operations for the second brake shoe steady post.
17. Readjust the wheel brake assembly as detailed by operation 12 132.
18. Raise the jack sufficiently to remove the axle stands. Remove the axle stands and lower the jack.
7. Place a wire, string or rubber band around the brake shoe expander tappets to prevent the rollers and wedge from falling out.
8. Hold the lower brake shoe and carrier and remove the carrier return springs.
9. Remove both brake shoes and carriers.
10. Note the brake lining residual code and marking on the side of the brake lining.

12 285 SHOES — REAR BRAKE — REMOVE AND INSTALL (ONE SIDE) (INCLUDES REMOVE AND INSTALL WHEEL AND ADJUST BOTH SIDES)

WARNING: When the brake drums are removed there is a certain quantity of dust around the brake shoes and in the brake drums. This dust contains asbestos and is dangerous if inhaled. Care must be exercised in the removal of the dust. Do not use an air line to blow the dust away. Use a vacuum cleaner. If a vacuum cleaner is not available use protective breathing equipment and remove the dust with a brush or rag. Collect the dust in a suitable plastic bag for removal.



H2L/S Rear Brake Assembly

- | | |
|------------------|-------------------|
| 1. Expander Unit | 3. Wheel Cylinder |
| 2. Adjuster Unit | 4. Return Spring |

H2L/S TYPE REAR BRAKE ASSEMBLIES

To Remove

NOTE: See illustrations for location of parts.

1. Chock the front wheels.
2. Place a jack under the rear axle and raise the vehicle sufficiently to enable axle stands to be placed under the rear axle at each end in the area within the spring 'U' bolts. Release the parking brake.
3. Remove the axle shaft as described in operation 16 322.
4. Place a wheel trolley in position under the wheels. Use a hub nut wrench (Tool No. 16 513A or 16 514B) to unscrew the hub bearing locknut. Remove the scalloped washer and the bearing adjusting nut. Remove the wheel, hub and drum assembly with the outer bearing cone.
5. Turn the rear wheel brake shoe adjusters in an anti-clockwise direction a few turns to slacken-off the brake shoes (see illustration).
6. Remove the brake shoe return springs using the special tool (Tool No. 64927025) or a suitable hook. Hook the tool in the eyelet of the



Removing the Brake Shoe Return Springs

1. Hooked Special Tool No. 64927025
2. Return Spring

SERVICE AND REPAIR OPERATIONS**Precautions**

- (a) Tilting the cab.
ALWAYS use the specified cab tilting procedure which is detailed in Section 44 00.
- (b) Jacking up the vehicle.
When jacking up the vehicle, using a hydraulic bottle jack, ensure the vehicle is on firm, level ground, the brakes are applied and the wheels are chocked. The jack must be positioned at the correct jacking points, which are inboard of the 'U' bolt clamps on the relevant side of the rear axle or under the lower leaf spring on the front axle.
- (c) Methyl alcohol used in the alcohol evaporator is injurious to health and proper care must be exercised when handling.
- (d) Asbestos brake lining dust can be injurious to health if inhaled. Any dust found in the brake drum must be removed by using a vacuum cleaner or soft brush. Do not blow the dust out using a compressed air supply. The dust should be collected in a sealed bag for disposal.
- (e) ALWAYS change brake shoes in axle sets. Do not renew shoes on one side of an axle only or unequal braking will occur.
- (f) ALWAYS clean the brake backplates before installing brake assemblies, and lightly lubricate the steady posts, operating levers, thrust pads, and abutment edges of the shoes with high melting point grease.
- (g) ALWAYS disconnect the battery before commencing repair operations.
- (h) ALWAYS reset the tachograph clock (where fitted) after reconnecting the battery.
- (i) ALWAYS refer to the applicable procedure when undertaking service and repair operations.

4. Tighten the union and check that an unbroken line of sealant is visible around the joint. A broken line indicates that the quantity of sealant applied is insufficient.

B. R.T.F. (Polytetrafluoroethylene) Tape (Ford Specification S-JM 46 9102A)

NOTE: This method of sealing should be used only if Loctite 572 is not available.

1. Thoroughly clean the threads of the union and mating component to remove traces of old sealant and dirt.
2. Apply the tape to the male thread, ensuring the tape is overlapped when pulled tight.
3. Screw the union into the component and tighten.

Joint Sealing

When any component of the braking system has been removed and the air lines disconnected, the following procedure must be observed for applying sealant to the threads of the union when the line is reconnected.

Two methods of sealing are available with Loctite 572 being the preferred method.

A. Loctite 572 (Ford Specification S-JM 46 9102A)

1. Thoroughly clean the threads of the union and mating component to remove traces of old sealant and dirt.
2. Screw the union into the mating component by approximately two turns.
3. Smear the threads of the union with Loctite 572 and screw the union fully into the component.

12 132 BRAKES — ADJUST

Front and Rear

1. Check the wheels, jack up the vehicle and fit stands. Release the park brake.
2. Spin the wheel and check that the bearings are free running.
3. Ensure that brake drums are cold. Turn the adjuster clockwise, whilst turning the wheel in the normal direction of rotation, until the shoes are in firm contact with the drum, preventing the wheel from being rotated.
4. Back-off the adjuster anti-clockwise until the shoes are just clear of the drum and the wheel can be rotated freely without binding.
5. Repeat the adjustment for the remaining wheels.
6. Remove the stands and lower the vehicle to the ground.

12 283 BRAKE SHOES — FRONT BRAKE — REMOVE AND INSTALL

To Remove

WARNING: Brake lining dust is injurious to health if inhaled and proper care must be taken when cleaning the brake drums and/or brake backplates.

1. Disconnect the battery earth (—) cable, chock the wheels, jack-up the vehicle and fit stands.
2. Slacken off the brake adjusters, and wind out and remove the spring brake release bolt.
3. Using a wheel trolley, remove the wheel and brake drum assembly as one unit, as detailed in Operation 14 371.
4. Using Girling Tool No. 649 47016 lever the lower end of the shoe from the adjuster, pull the shoe from the backplate to clear the adjuster and release the shoe. Both shoes can now be removed together with the springs.
5. Wire the tappets to keep them retracted.
6. Note the position of the retracting springs and remove the springs from the shoes. Remove the spring clips and bellcrank pivot pins, releasing the strut. Remove the strut from the shoes.

To Install

7. Refit the bell crank struts and pivot pins to the upper brake shoes. Refit the spring clips, noting that the central tongue of the clip tensions the bell cranks against the struts.



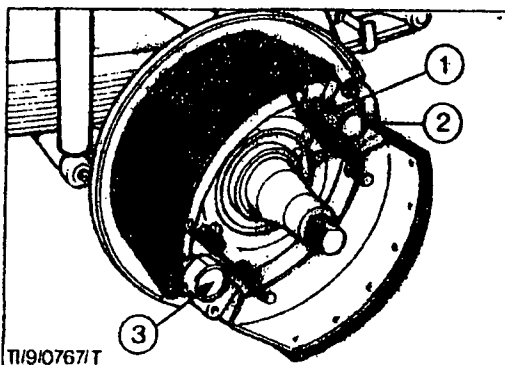
Front Brake Adjuster

1. Adjuster.



Rear Brake Adjuster

1. Adjuster.



TI/9/Q767/T

Front Brake Assembly

1. Retracting spring.
2. Expander.
3. Adjuster.

8. Refit new inner retracting springs to the shoes. The leading edges of each shoe must be chamfered and be equal diametrically to the rest of the shoe.
9. Fit the brake shoes and springs to the back plate with the leading edges of the shoes facing the direction of rotation. Refit the retaining pins and the tappets.

NOTE: On each shoe, the lining stops short of the leading end of the shoe, and in the portion not covered by the lining there is an aperture for access to the bell crank adjuster.

10. Ensure that the shoes are correctly located on the expander and the adjuster. Fit the new outer brake shoe retracting springs. Check that the yellow pair of springs are fitted to the ends of the brake shoes adjacent to the expander and the orange pair adjacent to the adjuster.
11. Ensure the expander tappet for the expanding shoe is fully home in the housing (the clip will be almost touching the housing) and adjust the bell crank lever adjuster to give the specified clearance between the shoe tip (leading edge) and the expander tappets. Check the clearance using feeler gauges. Hold the bell crank adjuster and tighten the locknut to the specified torque value.
12. Ensure that the brake shoe adjuster is fully released. Remove any dust and dirt from the assembly.
13. Refit the wheel and brake drum assembly as detailed in Operation 14 371, taking care not to damage the brake linings.
14. Adjust the brake shoes as detailed in Operation 12 132. Refit the spring brake release bolt and tighten to the specified torque.
15. Remove the axle stands and lower the vehicle. Reconnect the battery earth (-) cable.

12 285 BRAKE SHOES — REAR BRAKE — REMOVE AND INSTALL

To Remove

WARNING: Brake lining dust is injurious to health and proper care must be taken when cleaning the brake drums and/or brake back plates.

1. Disconnect the battery earth (-) cable, chock the wheels, jack up the vehicle and fit stands.
2. Slacken off the brake adjusters and wind out and remove the spring brake release bolt.
3. Unscrew the nuts from the axle shaft bolts, and withdraw the axle shaft, oil baffle, and gaskets.
4. Place a suitable wheel trolley in position under the wheels.
5. Using socket (Tool No. C-1041), remove the bearing locknut, lockwasher and bearing adjuster nut. Withdraw the wheel and hub assembly complete with the outer bearing cone.

8. Refit new inner retracting springs to the shoes. The leading edges of each shoe must be chamfered and be equal diametrically to the rest of the shoe.

9. Fit the brake shoes and springs to the back plate with the leading edges of the shoes facing the direction of rotation. Refit the retaining pins and the tappets.

NOTE: On each shoe, the lining stops short of the leading end of the shoe, and in the portion not covered by the lining there is an aperture for access to the bell crank adjuster.

10. Ensure that the shoes are correctly located on the expander and the adjuster. Fit the new outer brake shoe retracting springs. Check that the yellow pair of springs are fitted to the ends of the brake shoes adjacent to the expander and the orange pair adjacent to the adjuster.

NOTE: The shoes must be fitted so that the lining must be short of the leading edge of the shoe, and the portion not covered by the lining there is an aperture for access to the adjuster.

10. Fit the spring clip to retain the bell crank pivot pins to each shoe.
11. Fit the shoes with the leading edges chamfered and facing the direction of rotation and connect new inner retracting springs.



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Rear Brake Assembly

1. Brake shoe.
2. Expander.
3. Retracting springs.
4. Adjuster.

SERVICE AND REPAIR OPERATIONS

Precautions

- (a) Tilting the cab.
ALWAYS use the specified cab tilting procedure which is detailed in Section 44 00.
- (b) Jacking up the vehicle. When jacking up the vehicle, using a hydraulic bottle jack, ensure the vehicle is on firm, level ground, the brakes are applied and the wheels are chocked. The jack must be positioned at the correct jacking points, which are inboard of the U bolt clamps on the relevant side of the rear axle or under the lower leaf spring on the front axle.
- (c) Methyl alcohol used in the alcohol evaporator can be injurious to health if inhaled or taken internally, therefore, proper care must be exercised when handling.
- (d) *Asbestos brake lining dust can be injurious to health if inhaled. Any dust found in the brake drum must be removed by using a vacuum cleaner or soft brush. Do not blow the dust out using a compressed air supply. The dust should be collected in a sealed bag for disposal.*
- (e) ALWAYS change brake shoes in axle sets. Do not renew shoes on one side of an axle only or unequal braking will occur.
- (f) ALWAYS clean the brake backplates before installing brake assemblies, and lightly lubricate the steady posts, operating levers, thrust pads, and abutment edges of the shoes with high melting point grease.
- (g) ALWAYS disconnect the battery before commencing repair operations.
- (h) ALWAYS reset the tachograph clock (where fitted) after reconnecting the battery.
- (i) ALWAYS refer to the applicable procedure when undertaking service and repair operations.

Cleaning — General

It is recommended that, where possible, the exterior of components be steam cleaned, and dried with compressed air, prior to the commencement of any service and repair operations. This is to prevent the ingress of dirt during subsequent dismantling.

Cleaning — Hydraulic Brake Parts

Vegetable base hydraulic fluid (Specifications No. SM6C-1002-A) is used in the hydraulic system, therefore, mineral based cleaning fluids, oils or greases must not be allowed to contact the components. All hydraulic parts should be washed in either methylated spirits or commercial alcohol, or in the approved brake fluid.

Assembling — Hydraulic Brake Parts

Absolute cleanliness must be maintained during assembly of hydraulic brake parts, to ensure that no dirt is allowed to enter the system. Hydraulic seals and moving parts should be dipped in the approved brake fluid to facilitate ease of fitting and assist in preventing damage during assembly.

Joint Sealing

When any component of the braking system has been removed and the air lines disconnected, the following procedure must be observed for applying sealant to the threads of the union when the line is reconnected.

Two methods of sealing are available with Loctite 572 being the preferred method.

A. Loctite 572 (Ford Specification SJM 4G 9102A).

1. Thoroughly clean the threads of the union and mating component to remove traces of old sealant and dirt.
2. Screw the union into the mating component by approximately two turns.
3. Smear the threads of the union with Loctite 572 and screw the union fully into the component.
4. Tighten the union and check that an unbroken line of sealant is visible around the joint. A broken line indicates that the quantity of sealant applied is insufficient.

B. P.T.F.E. (Polytetrafluoroethylene) Tape (Ford Specification SM 4G 1019A).

NOTE: This method of sealing should be used only if Loctite 572 is not available.

1. Thoroughly clean the threads of the union and mating component to remove traces of old sealant and dirt.
2. Apply the tape to the male thread, ensuring the tape is overlapped when pulled tight.
3. Screw the union into the component and tighten.

August 1979

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- (c) The fluid in the reservoir should be of the correct specification (ie. GM-6C-1002A) and topped up level with the mark on the reservoir.
- (d) All brake pipe unions should be free from visible signs of leakage.

To Bleed the System

1. By repeatedly depressing the brake pedal, reduce the air pressure in the system until a gauge reading of between 2,0 to 3,5 kp/cm² (28,5 to 50 lb/in²) is indicated.

NOTE: It may be necessary to start and run the engine occasionally during the bleeding process to retain the above air pressure reading.

2. Commence to bleed at the bleed screw on the top of the Servo and cover, followed by the screw on the end-cap of the hydraulic (slave) cylinder.
3. Remove the rubber dust cap on the bleed valve and fit a rubber tube on the valve.
4. Immerse the end of the bleed tube in a clean jar containing new brake fluid. Keep the end of the tube below the surface of the fluid during the brake bleeding operation.
5. Open the bleed valve and slowly depress and release the brake pedal several times. Pause for an instant between each depression of the pedal to ensure full recuperation of the master cylinder. (If the master cylinder is sticking, overhaul the master cylinder as detailed in Operation 12 343 8). For each depression of the brake pedal some fluid or air should be emitted from the tube, if neither fluid nor air emerges, the bleed valve has not been opened properly or there is a blockage in the pipe line.
6. Continue depressing the brake pedal, until no more air bubbles emerge from the tube.

NOTE: It is important that the fluid level in the reservoir is maintained during the brake bleeding operation. NEVER replenish the reservoir with fluid drained from the system as it may be contaminated or aerated. If the fluid in the system is dirty it is advisable to drain it completely and refill with fresh fluid.

7. When, with each depression of the brake pedal, fluid starts to come out of the bleed tube, hold the footbrake pedal in the fully depressed position and tighten the bleed valve.

CAUTION: Do not use excessive force when tightening the valve.

8. Remove the tube and refit the rubber cap on the bleed valve.

9. Repeat operations 3 to 8 to bleed the wheel cylinders, starting at the wheel having the shortest pipeline run from the slave cylinder. Bleed at the wheel having the longest pipe line run last.

NOTE: The load apportioning valve must be bled before the rear wheel cylinders, using the same procedure as that for bleeding all other valves.

10. Top up the reservoir to the correct level and refit the cap.

12 283 SHOES — FRONT BRAKES — REMOVE AND INSTALL (One Side) (Includes: Adjust Both Sides)

WARNING: Brake lining dust is injurious to health if inhaled and proper care must be taken when cleaning the brake drums and/or back plates.

To Remove

1. Ensure that the park brake is applied.
2. Position a jack under the centre of the front axle and raise the vehicle sufficiently to fit stands under each end of the axle.
3. Using a wheel trolley, remove the wheel and brake drum assembly as one unit, as detailed in Operation 14 371.
4. Using the Brake Shoe Horn (Tool No. 64947016), prise one of the shoes from its abutment slot on the wheel cylinder.
5. Gradually release the tension on the shoe to enable the other shoe to be removed from its abutment slot on the other wheel cylinder.
6. Remove both shoes complete with the retracting springs.
7. Note the positions of the retracting springs and remove the springs from the shoes.
8. Wire the wheel cylinder pistons to keep them retracted.

To Install

NOTE: Ensure that the brake shoe lining material of the replacement shoes is of the correct specification. Check the letter code on the side of the brake shoe lining (see SPECIFICATIONS).

9. Refit the brake shoe retracting springs in the positions noted during removal.
10. Locate the shoe web of each brake shoe leading edge into the slot at the end of the wheel cylinder piston.

August 1979

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11. Remove the Brake Shoe Horn (Tool No. 64947016) from the ends of each brake shoe and remove the adjustment pins from the ends of the wheel cylinders. Remove the retaining wire from the cylinder pistons.
12. Remove the pins to remove the brake shoes from the wheel cylinders. Remove the shoe carriers from the brake carrier plate.
13. Remove the shoe carrier return springs from the shoe carriers. Remove the shoe carrier struts from the shoe carriers.
14. Remove the shoe carrier return springs from the shoe carriers.
15. Using the special Tool No. 64927026 or a suitable hook tool, unhook and remove the brake shoe retracting springs.
16. Repeat the operation on the other shoe.
17. Adjust the brakes as detailed in Operation 12.13.
18. Remove the stands and lower the vehicle to the ground.

8. Using the special Tool No. 64927026 or a suitable hook tool, unhook and remove the brake shoe retracting springs.
9. Wire around the expander tappets to retain the rollers and wedges in position.
10. Using the Brake Shoe Horn (Tool No. 64947016), prise the shoes from their abutment slots in the wheel cylinders and remove the shoe complete with shoe carriers from the brake carrier plate.
11. Wire the wheel cylinder pistons to keep them retracted.
12. Disconnect and remove the carrier return springs.
13. Remove the brake shoe carriers from the brake shoes.

To Install

NOTE: Ensure that the brake shoe lining material of the replacement shoes is of the correct specification. Check the letter code on the side of the brake shoe lining (see SPECIFICATIONS).

14. Position the upper brake shoe against the carrier plate and attach the inner retracting springs to the shoes.
15. Raise the brake shoe and fit the shoe carrier and carrier strut.
16. Continue to raise until the brake shoe is located in the upper slots on the ends of the wheel cylinders, and the shoe carrier is located, one end in the slot of the shoe adjuster, and the other end in the slot of the expander unit.
17. Position the lower brake shoe and shoe carrier, locating the carrier in the slots of the lower ends of the shoe adjuster and expander units.
18. Fit the shoe carrier return springs.
19. Ensure that the lower brake shoes are located in the slots of the wheel cylinders, and using the special Tool No. 64927026 or a suitable hook tool, fit the inner retracting springs to the lower shoes.
20. Position and fit the outer retracting springs to the shoes.
21. Remove the retaining wire from around the expander tappets and wheel cylinders.
22. Adjust the clearance between the brake shoe carrier strut and the brake shoe as follows:-
(a) Ensure that the brake shoes are central.

12.20 SERVICE - REAR BRAKES - REMOVE AND INSTALL (One Side) (Illustration: Wheel Cylinders, Shoe and Adjuster)

WARNING: Do not use compressed air to clean the face of the brake shoe lining. This may cause the lining to become airborne and be inhaled.

To Remove (One Side)

1. Check the front wheels.
2. Slacken the wheel nuts.
3. Position a jack under the centre of the rear axle and raise the vehicle sufficiently to fit stands under each end of the axle.
4. Release the park brake.
5. Remove the wheel nuts and, using a wheel trolley, remove the wheel.
6. Remove the hub and brake drum assembly as detailed in Operation 15.374.
7. Slacken the brake shoe adjusters.



- (b) Slacken off the locking grub screw at the side of the shoe carrier.
 - (c) Unscrew the adjuster screw until the carrier strut is clear of the brake shoe.
 - (d) Position a 0,127 mm (0,005 in) feeler gauge between the carrier strut and the brake shoe, and tighten the adjuster screw until the feeler gauge is trapped. Remove the feeler gauge and lock the adjuster screw with the grub screw.
 - (e) Repeat the operation on the other shoe.
23. Install the hub and brake drum assembly as detailed in Operation 15 374.
 24. Refit the wheel.
 25. Remove the two rubber plugs at the rear of the brake dust cover to expose the brake shoe steady posts, slacken the steady post locknuts and unscrew both steady posts two full turns using Adjuster Tool No. 64927025.
 26. Turn the brake adjusters in a clockwise direction until the shoes are in firm contact with the drum.
 27. Using the Adjuster Tool No. 64927025, screw in one steady post until it just contacts the brake shoe web, then tighten the locknut. Refit the steady post rubber plug.
 28. Repeat the operation on the other shoe steady post.
 29. Adjust the brakes as detailed in Operation 12 132.
 30. Remove the stands and lower the vehicle to the ground and tighten the wheel nuts.

12 285 3 SHOES - REAR BRAKES - REMOVE AND INSTALL (One Side) (Rear Brake Drum Removed)

WARNING: Brake lining dust is injurious to health if inhaled and proper care must be taken when cleaning the brake drums and/or back plates.

To Remove (Duo-Servo with Automatic Adjustment)

1. Remove the secondary brake shoe holding down springs by exerting slight pressure on the spring caps and twisting to line up the slots in the caps with the tags on the spring anchor pins.

NOTE: Note the positions of the automatic adjustment linkage before removal.

2. Remove the wire link from the actuating lever and the brake shoe anchor pin sleeve.

3. Remove the secondary shoe from the backplate with the shoe web abutting the anchor pin.
4. Remove the shoe holding down spring.
5. Remove the split pin and withdraw the brake shoe anchor pin retaining cap.
6. Remove the operating lever from the anchor pin and disconnect the park brake cable.
7. Remove the primary shoe holding down spring by exerting slight pressure on the spring caps and twisting to line up the slots in the caps with the tags on the spring anchor pins.
8. Press the shoes against the drum to compress the brake shoe adjuster and the shoe release spring.
9. Using the Adjuster Tool No. 64927025, lever the secondary shoe away from its adjustment position to the anchor pin and screw down the steady post. Gradually release the shoe and the shoe retracting spring can be removed. Remove the shoes.

NOTE: The brake shoe anchor pin must not be removed unless it is badly worn or damaged. If it becomes necessary to fit a new anchor pin the fitting instructions supplied with the new pin must be strictly adhered to.

To Install

NOTE: Ensure that the brake shoe lining material of the replacement shoes is of the correct specification. Check the letter code on the side of the brake shoe lining (see SPECIFICATIONS). With the Duo-Servo system the secondary shoe lining is subjected to excessive loads. To ensure the resultant uneven wear the secondary shoe lining is thicker than that of the primary shoe.

10. Position the primary shoe with the shoe web abutting the backplate with the shoe web abutting the anchor pin and in the slot in the wheel cylinder.
11. Refit the shoe holding down springs and spring caps to the spring anchor pins. With the slots in the spring caps aligned with the tags of the spring anchor pins, depress the caps over the anchor pins, twist and release, to retain in position.
12. Attach the end of the shoe retaining spring with the most number of coils to the primary brake shoe, and the opposite end to the secondary brake shoe.
13. Position the secondary brake shoe against the backplate with the shoe web abutting the anchor pin and in the slot in the wheel cylinder.

3. Remove all the asbestos clutch lining dust from the clutch pressure plate, the clutch disc and the flywheel.

WARNING: Asbestos dust is injurious to health and must not be inhaled. Do not blow the dust off with an air line. Use a suitable vacuum cleaner. If a vacuum cleaner is not available, use personal protective breathing equipment or a suitable face mask and remove the dust carefully with a brush or rag. Collect the dust in a sealable plastic bag or envelope for disposal.

4. Inspect the pressure plate assembly generally for damaged or worn parts. In particular check the friction surface for scoring, discolouration or cracks.
5. (a) On the axial spring clutch check the operating lever ends for wear. Check also for broken coil springs.
- (b) On the diaphragm spring clutch check the diaphragm spring for cracks or broken sectors and for excessive wear on the ends of the sectors at the centre.
- (c) If these or any other defects are present, replace with a new pressure plate assembly.
6. Inspect the clutch disc for wear on the friction linings, check to see if they are worn down near to the rivet heads. Check the linings as well for oil contamination. Check the buffer springs for cracks or breakage and also that they are not loose in the housings. If these or any other defects are present, replace with a new clutch disc.
7. Inspect the flywheel friction surface for scoring, discolouration or cracks. If the flywheel is unserviceable fit a new part as detailed in operation 21 582 4.

To install

8. Lightly grease the splines in the clutch disc hub.

CAUTION: Only the very slightest film of grease should be applied as any excess will be thrown out and may contaminate the friction linings.

9. Place the clutch disc in position on the flywheel with the shortest spigot of the splined hub towards the flywheel. Place the clutch disc/flywheel pilot bearing alignment tool in position. Select an alignment tool according to clutch disc diameter:

306 mm (12 in) diameter clutch: Tool No. C-7088
330 mm (13 in) diameter clutch: Tool No. 18515

10. Place the pressure plate in position and hold it against the clutch disc. On vehicles fitted with the 330 mm (13 in) diameter clutch disc or diaphragm spring ensure that the dowels in the flywheel are aligned with the dowel holes in the pressure plate cover.
11. Enter all the securing bolts together with new lockwashers and screw them in until they are all just lightly clamping the pressure plate.
12. Screw in each bolt one turn at a time to carefully and evenly pull the pressure plate up to the flywheel and load the pressure plate springs. Ensure that the dowels engage correctly with the flywheel holes. Finally tighten the bolts to the specified torque (see specification).
13. Remove the disc alignment tool.

Ford and Gleanline V8 Engines Models

To remove

1. Clutch housing removed, refer to operation 10 724 4.
2. Blocken and unscrew slowly and gradually the bolts securing the clutch pressure plate to the flywheel. Remove the bolts, the pressure plate, the first clutch disc, the intermediate plate and the second disc.
3. Remove all the asbestos clutch lining dust from the clutch pressure plate, the two discs, the intermediate plate and the flywheel.



Alignment Tool. Clutch disc splines with the Alignment Tool.

1. Alignment Tool.

8006 1265

PQ

September 1979

D Series

WARNING: The clutch disc is injurious to health and should not be inhaled. Do not breathe dust with the air line. Use a vacuum cleaner to clean. If a vacuum cleaner is not available, use personal protection breathing equipment or a respirator. Do not use a brush or rag. Collect the dust in a separate plastic bag or envelope for disposal.

4. Inspect the pressure plate assembly generally for damaged or worn parts. In particular check:

- (a) the friction surface for scoring, discoloration or cracks,
- (b) the operating lever ends for wear,
- (c) the broken coil springs.

If there are any other defects are present, replace with a new pressure plate assembly.

5. Inspect the intermediate plate for scoring, discoloration or cracks. Check also the coil springs for cracks or breakage. If there are any other defects are present replace with a new intermediate plate.

6. Inspect the two clutch discs for wear on the friction linings. Check to see if the linings are worn down nearly to the rivet heads. Check the linings for oil contamination. Check the buffer springs for cracks or breakage and also that they are properly in the housings. If there are any other defects are present replace one or both clutch discs as necessary with a new disc.

7. Inspect the flywheel friction surface for scoring, discoloration or cracks. If the flywheel is damaged fit a new part as specified in section 41 682 4.

To Install

8. Tilt the plate the splines in the hub of the flywheel.

CAUTION: The plate is very hot and should be handled with care. Do not touch the plate with bare hands. Do not touch the plate with bare hands.

9. Push the spigot end of the clutch disc into the pilot bearing of the flywheel (see G-7139) in the flywheel plate.

10. Push the disc on the alignment tool with the longest spigot of the alignment tool towards the flywheel. Slide the disc up against the flywheel.

11. Place the intermediate plate in position against the first disc with the four driving lugs engaged in the four driving slots on the flywheel and the centralising last springs on each lug in a trailing position relative to flywheel rotation. Slide the plate up against the first disc. Take note of the position of the letter 'L' stamped on the plate.

12. Place the second clutch disc on the alignment tool with the longest spigot of the splined hub towards the flywheel. Slide the disc up against the intermediate plate.

13. Hold the clutch pressure plate in position against the second disc with the letter 'H' stamped on the cover as near as possible to the letter 'L' on the intermediate plate. Ensure that the dowels in the flywheel are aligned with the dowel holes in the clutch pressure plate cover.

14. Enter all the securing bolts with new lockwashers and screw them in until they are just lightly clamping the pressure plate.

15. Screw in each bolt one turn at a time to carefully and evenly pull the pressure plate up to the flywheel and load the pressure plate springs. Ensure that the dowels engage correctly with the dowel holes. Finally tighten the bolts to the specified torque (see specifications).

16. Remove the disc alignment tool.

16 784 4 CLUTCH HOUSING — REMOVE AND INSTALL (Transmission Removed)

In-Line Diesel Engine Models

To Remove

1. Tilt the cab as described in section 44.
2. Slacken, unscrew and remove the two bolts securing the clutch slave cylinder. Do not remove the push rod or the rubber boot from the slave cylinder. Swing the cylinder aside and suitably support it to prevent damage to the hydraulic fluid line.

NOTE: On all vehicles fitted with four (4-410-S), six and eight speed transmissions, the slave cylinder is mounted on a cast extension bracket on the clutch housing. On vehicles fitted with the Ford 4-310 transmission the slave cylinder is mounted on a flange on the clutch release arm.

3. Remove the battery cover and disconnect the batteries.

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4. On vehicles fitted with 4-310 transmission, unhook and remove the clutch release arm return spring from the bracket on the clutch housing and the lug on the arm.
5. Place a suitable jack under the clutch housing portion of the sump and support the engine.
6. Slide the clutch release bearing and hub assembly off the fingers of the release arm fork and withdraw the bearing and hub assembly via the transmission main drive shaft aperture in the clutch housing.
7. Press the clutch release bearing off the hub.
8. Slacken, unscrew and remove the self locking nut and the centre bolt from the engine right-hand rear mounting.
9. Slacken, unscrew and remove the four bolts securing the engine right-hand rear mounting bracket to the clutch housing and withdraw the bracket.
10. Slacken, unscrew and remove the four bolts securing the engine left-hand rear mounting bracket to the clutch housing.
11. Slacken, unscrew and remove the fifteen bolts securing the clutch housing to the engine. Move aside any cables or pipes that were clipped to the housing. Pull the housing off the two locating dowels and lower it to the floor. Move the housing away from the vehicle.
12. Remove all the asbestos clutch lining dust from the clutch housing.

WARNING: Asbestos dust is injurious to health and must not be inhaled. Do not blow the dust off with an air line. Use a suitable vacuum cleaner. If a vacuum cleaner is not available, use personal protective breathing equipment or a suitable face mask and remove the dust carefully with a brush or rag. Collect the dust in a suitable plastic bag or envelope for disposal.

13. Remove the clutch release arm rubber gaiter from the clutch housing aperture and pull it off the release arm.
14. Pull the clutch release arm to disengage it from the trunnion pivot ball and remove the arm from the housing.
15. Slacken, unscrew and remove the release arm pivot trunnion ball from the clutch housing.

16. On vehicles fitted with the Ford 4-310 transmission, slacken the clutch release arm free play adjusting centre bolt without assembly into its location in the clutch housing.
17. Thoroughly wash and clean all component parts. Discard the old release bearing, self locking nut and lockwasher.
18. Inspect all parts for excessive wear or damage. Replace all undersize parts with new parts.

To install

19. On vehicles fitted with the Ford 4-310 transmission, slacken the clutch release arm free play adjusting centre bolt without assembly into its location in the clutch housing.
20. Screw the release arm pivot trunnion ball into its location inside the clutch housing together with a new lockwasher (and tighten to the specified torque (see specifications)).
21. Place a smear of grease on both the pivot trunnion ball and in the ball socket in the release arm. Lift the retaining spring clip with a screwdriver and slide the arm over the ball until the ball is engaged securely in the socket. Release the retaining spring clip.
22. Pull a new release arm rubber gaiter over the arm and position the gaiter around the rim of the clutch housing aperture.
23. Press the clutch release bearing onto the hub.

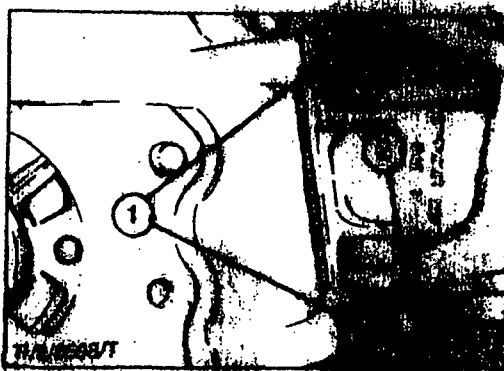


Diagram illustrating mounting

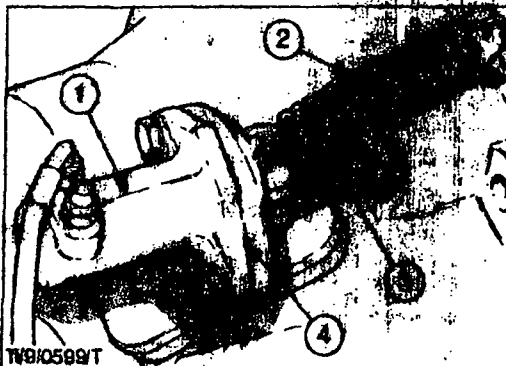
1. Rear mounting bracket bolts.
2. Rear mounting centre bolt.

Petrol Engine Models

1. Tilt the cab as described in section 44.
2. On vehicles fitted with four (4-410-S), six and eight speed transmissions, slacken, unscrew and remove the two bolts securing the clutch slave cylinder to the clutch housing. Do not remove the push rod or the rubber boot from the slave cylinder. Swing the cylinder aside and suitably support to prevent damage to the hydraulic fluid line.
3. Remove the battery cover and disconnect the batteries.
4. Slacken, unscrew and remove the nut securing the starter motor electrical lead to the starter motor and disconnect the lead.
5. Slacken, unscrew and remove the two bolts securing the starter motor and remove the starter motor.
6. Slacken, unscrew and remove the four bolts securing the flywheel lower front cover and remove the cover.
7. On vehicles fitted with the 4-310 transmission, slacken, unscrew and remove the five bolts securing the clutch housing bottom cover and remove the cover.
8. Slide the clutch release bearing and hub assembly off the fingers of the release arm fork and withdraw the bearing and hub assembly via the transmission's main drive shaft aperture in the clutch housing.
9. Press the clutch release bearing off the hub.
10. Place a suitable jack under the sump at the rear of the engine with a piece of soft timber between the jack and the sump. Raise the jack to take the weight of the engine.
11. Slacken, unscrew and remove the self locking nut from the clutch housing to chassis cross member mounting bolt on each side of the housing. Withdraw the bolts together with the flat washers, lower insulators and the distance tubes.
12. Slacken, unscrew and remove the six bolts securing the clutch housing to the engine. Move aside any cables or pipes that were clipped to the housing. On vehicles fitted with the 4-310 transmission the two bolts on the left-hand side also retain the clutch slave cylinder. Move the cylinder aside and suitably support to prevent damage to the hydraulic pipe.
13. Raise the jack slightly to lift the housing lugs off the upper insulators.
14. Pull the clutch housing off the two locating dowels and lower it to the floor. Remove the two upper insulators from the cross member area. Move the housing away from the vehicle.
15. Remove all the asbestos clutch lining dust from the clutch housing.

WARNING: Asbestos dust is injurious to health and must not be inhaled. Do not blow the dust off with an air gun. Use a suitable vacuum cleaner. If a vacuum cleaner is not available, use personal protective breathing equipment or a suitable face mask and remove the dust carefully with a brush or rag. Collect the dust in a suitable plastic bag or envelope for disposal.

16. On vehicles fitted with the 4-310 transmission, unhook the clutch release arm return spring from the lug on the housing and from the lug on the arm and remove the spring.
17. Remove the clutch release arm rubber gaiter from the clutch housing aperture and pull it off the release arm.
18. Pull the clutch release arm to disengage it from the transmission pivot ball and remove the arm from the housing.
19. Slacken, unscrew and remove the release arm pivot trunnion ball from the clutch housing.



Release Arm and Slave Cylinder Assembly - 4-310 Transmission

- | | |
|-------------------------------|-------------------------------|
| 1. Hydraulic slave cylinder. | 3. Free end of return spring. |
| 2. Release arm return spring. | 4. Release arm. |

40. On vehicles fitted with four (4-410-S), six and eight speed transmissions, place the clutch slave cylinder in position on the clutch housing cast bracket ensuring that the push rod engages correctly with the clutch release arm. Screw in the two retaining bolts together with new lockwashers and tighten to the specified torque (see specifications).
41. Pass the release bearing and hub assembly through the transmission main drive shaft aperture in the clutch housing and slide it into position on the release arm fork.
42. Lower the cab as described in section 44.
4. Slacken, unscrew and remove the union adaptor from the release bearing hub. Press the bearing off the hub.
5. Slacken, unscrew and remove eleven of the twelve bolts securing the clutch housing to the engine leaving one bolt at the top. Move aside any cables or pipes that were clipped to the housing.
6. Hold the housing, slacken, unscrew and remove the final top bolt and lower the clutch housing to the floor. Remove the housing from the vehicle.
7. Remove all the asbestos clutch lining dust from the clutch housing.

Ford and Cummins V8 Diesel Engine Models

To Remove

1. Tilt the cab as described in section 44.
2. (a) On vehicles fitted with a hydraulic clutch slave cylinder slacken, unscrew and remove the two bolts securing the clutch slave cylinder to its mounting block on the clutch housing. Do not remove the push rod or the rubber boot from the slave cylinder. Withdraw the cylinder and push rod assembly from the mounting block, swing the cylinder aside and support it to prevent damage to the hydraulic fluid line.
- (b) On vehicles equipped with an air assisted clutch slave cylinder slacken, unscrew and remove the two bolts securing each trunnion in the slave cylinder mounting bracket on the clutch housing. Withdraw the two trunnions and remove the slave cylinder and the two side packing washers from the clutch housing. Swing the slave cylinder aside and support it to prevent damage to the hydraulic fluid and air lines.

NOTE: Before removing the air assisted clutch slave cylinder on vehicles with the Cummins V8 engine it may be necessary to move that part of the fuel return system adjacent to the slave cylinder upper trunnion. If this is necessary plug all open fuel lines.

3. Withdraw the clutch release bearing and hub assembly from the clutch housing via the transmission main drive shaft aperture. Slacken, unscrew and disconnect the grease lubrication pipe union nut on the release bearing hub and remove the bearing and hub assembly.

WARNING: Asbestos dust is injurious to health and must not be inhaled. Do not blow the dust off with an air line. Use a suitable vacuum cleaner. If a vacuum cleaner is not available, use personal protective breathing equipment or a suitable face mask and remove the dust carefully with a brush or rag. Collect the dust in a suitable plastic bag or envelope for disposal.

8. Slacken and unscrew the union on the release bearing grease lubrication pipe at the grease nipple end and remove the pipe.
9. Slacken, unscrew and remove the two grease nipples on the side of the housing.
10. Remove the clutch release arm rubber gaiter from the clutch housing aperture and pull it off the release arm.
11. Pull the clutch release arm to disengage it from the trunnion pivot ball and remove the arm from the housing.
12. Slacken, unscrew and remove the release arm pivot trunnion ball from the clutch housing.
13. On vehicles with the hydraulic slave cylinder slacken, unscrew and remove the two bolts securing each trunnion in the slave cylinder mounting cast bracket on the clutch housing. Withdraw the two trunnions and remove the slave cylinder mounting block.
14. Thoroughly wash and clean all component parts. Discard the old rubber gaiter and all lockwashers. Inspect all parts for excessive wear or damage. Replace all unserviceable parts with new parts.

August 1979

D Series

SERVICE AND REPAIR OPERATIONS

Precautions

- (a) Tilting the cab.
ALWAYS use the specified cab tilting procedure which is detailed in Section 44 00.
- (b) Jacking up the vehicle. When jacking up the vehicle, using a hydraulic bottle jack, ensure the vehicle is on firm, level ground, the brakes are applied and the wheels are chocked. The jack must be positioned at the correct jacking points, which are inboard of the 'U' bolt clamps on the relevant side of the rear axle or under the lower leaf spring on the front axle.
- (c) Methyl alcohol used in the alcohol evaporator can be injurious to health if inhaled or taken internally, therefore, proper care must be exercised when handling.

(d) *Asbestos brake lining dust can be injurious to health if inhaled. Any dust found in the brake drum must be removed by using a vacuum cleaner or soft brush. Do not blow the dust out using a compressed air supply. The dust should be collected in a sealed bag for disposal.*

- (e) ALWAYS change brake shoes in axle sets. Do not renew shoes on one side of an axle only or unequal braking will occur.
- (f) ALWAYS clean the brake backplates before installing brake assemblies, and lightly lubricate the steady posts, operating levers, thrust pads, and abutment edges of the shoes with high melting point grease.
- (g) ALWAYS disconnect the battery before commencing repair operations.
- (h) ALWAYS reset the tachograph clock (where fitted) after reconnecting the battery.
- (i) ALWAYS refer to the applicable procedure when undertaking service and repair operations.

Cleaning — General

It is recommended that, where possible, the exterior of components be steam cleaned, and dried with compressed air, prior to the commencement of any service and repair operations. This is to prevent the ingress of dirt during subsequent dismantling.

Cleaning — Hydraulic Brake Parts

Vegetable base hydraulic fluid (Specifications No. SM6C-1002-A) is used in the hydraulic system, therefore, mineral based cleaning fluids, oils or greases **must not** be allowed to contact the components. All hydraulic parts should be washed in either methylated spirits or commercial alcohol, or in the approved brake fluid.

Assembling — Hydraulic Brake Parts

Absolute cleanliness must be maintained during assembly of hydraulic brake parts, to ensure that no dirt is allowed to enter the system. Hydraulic seals and moving parts should be dipped in the approved brake fluid to facilitate ease of fitting and assist in preventing damage during assembly.

Joint Sealing

When any component of the braking system has been removed and the air lines disconnected, the following procedure must be observed for applying sealant to the threads of the union when the line is reconnected.

Two methods of sealing are available with Loctite 572 being the preferred method.

A. Loctite 572 (Ford Specification SJM 4G 9102A).

1. Thoroughly clean the threads of the union and mating component to remove traces of old sealant and dirt.
2. Screw the union into the mating component by approximately two turns.
3. Smear the threads of the union with Loctite 572 and screw the union fully into the component.
4. Tighten the union and check that an unbroken line of sealant is visible around the joint. A broken line indicates that the quantity of sealant applied is insufficient.

B. P.T.F.E. (Polytetrafluoroethylene) Tape (Ford Specification SM 4G 1019A).

NOTE: This method of sealing should be used only if Loctite 572 is not available.

1. Thoroughly clean the threads of the union and mating component to remove traces of old sealant and dirt.
2. Apply the tape to the male thread, ensuring the tape is overlapped when pulled tight.
3. Screw the union into the component and tighten.

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- (c) The fluid in the reservoir should be of the correct specification (ie. SM-6C-1002A) and topped up level with the mark on the reservoir.
- (d) All brake pipe unions should be free from visible signs of leakage.

To Bleed the System

1. By repeatedly depressing the brake pedal, reduce the air pressure in the system until a gauge reading of between 2,0 to 3,5 kp/cm² (28,5 to 50 lb/in²) is indicated.

NOTE: It may be necessary to start and run the engine occasionally during the bleeding process to retain the above air pressure reading.

2. Commence to bleed at the bleed screw on the top of the Servo end cover, followed by the screw on the end-cap of the hydraulic (slave) cylinder.
3. Remove the rubber dust cap on the bleed valve and fit a rubber tube on the valve.
4. Immerse the end of the bleed tube in a clean jar containing new brake fluid. Keep the end of the tube below the surface of the fluid during the brake bleeding operation.
5. Open the bleed valve and slowly depress and release the brake pedal several times. Pause for an instant between each depression of the pedal to ensure full recuperation of the master cylinder. (If the master cylinder is sticking, overhaul the master cylinder as detailed in Operation 12 343 8). For each depression of the brake pedal some fluid or air should be emitted from the tube, if neither fluid nor air emerges, the bleed valve has not been opened properly or there is a blockage in the pipe line.
6. Continue depressing the brake pedal, until no more air bubbles emerge from the tube.

NOTE: It is important that the fluid level in the reservoir is maintained during the brake bleeding operation. NEVER replenish the reservoir with fluid drained from the system as it may be contaminated or aerated. If the fluid in the system is dirty it is advisable to drain it completely and refill with fresh fluid.

7. When, with each depression of the brake pedal, fluid alone comes out of the bleed tube, hold the footbrake pedal in the fully depressed position and tighten the bleed valve.

CAUTION: Do not use excessive force when tightening the valve.

8. Remove the tube and refit the rubber cap on the bleed valve.

9. Repeat operations 3 to 8 to bleed the wheel cylinders, starting at the wheel having the shortest pipeline run from the slave cylinder. Bleed at the wheel having the longest pipe line run last.

NOTE: The load apportioning valve must be bled before the rear wheel cylinders, using the same procedure as that for bleeding all other valves.

10. Top up the reservoir to the correct level and refit the cap.

12 283 SHOES — FRONT BRAKES — REMOVE AND INSTALL (One Side) (Includes: Adjust Both Sides)

WARNING: Brake lining dust is injurious to health if inhaled and proper care must be taken when cleaning the brake drums and/or back plates.

To Remove

1. Ensure that the park brake is applied.
2. Position a jack under the centre of the front axle and raise the vehicle sufficiently to fit stands under each end of the axle.
3. Using a wheel trolley, remove the wheel and brake drum assembly as one unit, as detailed in Operation 14 371.
4. Using the Brake Shoe Horn (Tool No. 64947016), prise one of the shoes from its abutment slot on the wheel cylinder.
5. Gradually release the tension on the shoe to enable the other shoe to be removed from its abutment slot on the other wheel cylinder.
6. Remove both shoes complete with the retracting springs.
7. Note the positions of the retracting springs and remove the springs from the shoes.
8. Wire the wheel cylinder pistons to keep them retracted.

To Install

NOTE: Ensure that the brake shoe lining material of the replacement shoes is of the correct specification. Check the letter code on the side of the brake shoe lining (see SPECIFICATIONS).

9. Refit the brake shoe retracting springs in the positions noted during removal.
10. Locate the shoe web of each brake shoe leading edge into the slot at the end of the wheel cylinder piston.

11. Using the Brake Shoe Horn (Tool No. 64947016), lever the shoe web of each brake shoe trailing edge into its abutment slot at the rear end of the wheel cylinder. Remove the retaining wire from the cylinder pistons.
12. Taking care not to damage the brake linings, refit the wheel and brake drum assembly as detailed in Operation 14 371.
13. Remove the two rubber plugs at the rear of the brake dust cover which cover the brake shoe steady posts, slacken the steady post locknuts and unscrew both steady posts two full turns using Adjuster Tool No. 64927025.
14. Turn the brake adjusters in a clockwise direction until the shoes are in firm contact with the drum.
15. Using the Adjuster Tool No. 64927025, screw in one steady post until it just contacts the brake shoe web, then tighten the locknut. Refit the steady post rubber plug.
16. Repeat the operation on the other shoe steady post.
17. Adjust the brakes as detailed in Operation 12 132.
18. Remove the stands and lower the vehicle to the ground.

12 285 SHOES — REAR BRAKES — REMOVE AND INSTALL (One Side) (Includes: Remove and Install Wheel and Adjust Both Sides).

WARNING: Brake lining dust is injurious to health if inhaled and proper care must be taken when cleaning the brake drums and/or back plates.

To Remove (H2 L/S)

1. Chock the front wheels.
2. Slacken the wheel nuts.
3. Position a jack under the centre of the rear axle and raise the vehicle sufficiently to fit stands under each end of the axle.
4. Release the park brake.
5. Remove the wheel nuts and, using a wheel trolley, remove the wheel.
6. Remove the hub and brake drum assembly as detailed in Operation 15 374.
7. Slacken the brake shoe adjusters.
8. Using the special Tool No. 64927026 or a suitable hook tool, unhook and remove the brake shoe retracting springs.
9. Wire around the expander tappets to retain the rollers and wedge in position.
10. Using the Brake Shoe Horn (Tool No. 64947016), prise the shoes from their abutment slots in the wheel cylinders and remove the shoes complete with shoe carriers from the brake carrier plate.
11. Wire the wheel cylinder pistons to keep them retracted.
12. Disconnect and remove the carrier return springs.
13. Remove the brake shoe carriers from the brake shoes.

To Install

NOTE: Ensure that the brake shoe lining material of the replacement shoes is of the correct specification. Check the letter code on the side of the brake shoe lining (see SPECIFICATIONS).

14. Position the upper brake shoe against the carrier plate and attach the inner retracting springs to the shoes.
15. Raise the brake shoe and fit the shoe carrier and carrier strut.
16. Continue to raise until the brake shoe is located in the upper slots on the ends of the wheel cylinders, and the shoe carrier is located, one end in the slot of the shoe adjuster, and the other end in the slot of the expander unit.
17. Position the lower brake shoe and shoe carrier, locating the carrier in the slots at the lower ends of the shoe adjuster and expander units.
18. Fit the shoe carrier return springs.
19. Ensure that the lower brake shoes are located in the slots of the wheel cylinders, and using the special Tool No. 64927026 or a suitable hook tool, fit the inner retracting springs to the lower shoes.
20. Position and fit the outer retracting springs to the shoes.
21. Remove the retaining wire from around the expander tappets and wheel cylinders.
22. Adjust the clearance between the brake shoe carrier strut and the brake shoe as follows:-
 - (a) Ensure that the brake shoes are central.

- (b) Slacken off the locking grub screw at the side of the shoe carrier.
 - (c) Unscrew the adjuster screw until the carrier strut is clear of the brake shoe.
 - (d) Position a 0,127 mm (0,005 in) feeler gauge between the carrier strut and the brake shoe, and tighten the adjuster screw until the feeler gauge is trapped. Remove the feeler gauge and lock the adjuster screw with the grub screw.
 - (e) Repeat the operation on the other shoe.
23. Install the hub and brake drum assembly as detailed in Operation 15 374.
 24. Refit the wheel.
 25. Remove the two rubber plugs at the rear of the brake dust cover to expose the brake shoe steady posts, slacken the steady post locknuts and unscrew both steady posts two full turns using Adjuster Tool No. 64927025.
 26. Turn the brake adjusters in a clockwise direction until the shoes are in firm contact with the drum.
 27. Using the Adjuster Tool No. 64927025, screw in one steady post until it just contacts the brake shoe web, then tighten the locknut. Refit the steady post rubber plug.
 28. Repeat the operation on the other shoe steady post.
 29. Adjust the brakes as detailed in Operation 12 132.
 30. Remove the stands and lower the vehicle to the ground and tighten the wheel nuts.

12 285 3 SHOES — REAR BRAKES — REMOVE AND INSTALL (One Side) (Rear Brake Drum Removed)

WARNING: Brake lining dust is injurious to health if inhaled and proper care must be taken when cleaning the brake drums and/or back plates.

To Remove (Duo-Servo with Automatic Adjustment)

1. Remove the secondary brake shoe holding down springs by exerting slight pressure on the spring caps and twisting to line up the slots in the caps with the tags on the spring anchor pins.

NOTE: Note the positions of the automatic adjustment linkage before removal.

2. Remove the wire link from the actuating lever and the brake shoe anchor pin sleeve.

3. Remove the actuating lever from the secondary brake shoe and pawl lever.
4. Remove the pawl lever and conical spring.
5. Remove the split pin and unscrew the brake anchor pin retaining nut.
6. Remove the operating cam from the anchor pin and disconnect the park brake cable.
7. Remove the primary shoe holding down springs by exerting slight pressure on the spring caps and twisting to line up the slots in the caps with the tags on the spring anchor pins.
8. Prise the brake shoes apart and remove the brake shoe adjuster and the lower shoe retaining spring.
9. Using the Brake Shoe Horn (Tool No. 64947016), lever each brake shoe away from its abutment positions on the anchor pin and wheel cylinder, and gradually release the shoes until the shoe retracting spring can be removed. Remove the shoes.

NOTE: The brake shoe anchor pin must not be removed unless it is badly worn or damaged. If it becomes necessary to fit a new anchor pin the fitting instructions supplied with the new pin must be strictly adhered to.

To Install

NOTE: Ensure that the brake shoe lining material of the replacement shoes is of the correct specification. Check the letter code on the side of the brake shoe lining (see SPECIFICATIONS). With the Duo-Servo system the secondary shoe lining is subjected to excessive loads. To combat the resultant uneven wear the secondary shoe lining is thicker than that of the primary shoe.

10. Position the primary brake shoe against the backplate with the shoe web abutting the anchor pin and in the slot in the wheel cylinder.
11. Refit the shoe holding down springs and spring caps to the spring anchor pins. With the slots in the spring caps aligned with the tags of the spring anchor pins, depress the caps over the anchor pins, twist and release, to retain in position.
12. Attach the end of the shoe retaining spring with the most number of coils to the primary brake shoe, and the opposite end to the secondary brake shoe.
13. Position the secondary brake shoe against the backplate with the shoe web abutting the anchor pin and in the slot in the wheel cylinder.

SERVICE AND REPAIR OPERATIONS**General Precautions**

Before commencing any repairs or adjustments that involve tilting the cab the correct tilting procedure, described in section 44, must be strictly adhered to.

WARNING: It is dangerous not to follow the correct procedure.

Brake Assemblies

Brake shoes must only be changed in complete axle sets. Do not replace shoes on one side of an axle as this may cause unequal braking and result in a dangerous condition on the road.

Extreme care should be taken when removing the brake shoes to avoid damage to the wheel cylinders, rubber boots or dust covers.

Before installing brake assemblies clean the back plate and lightly lubricate, with high melting point grease, the steady posts, anchor or fulcrum pins, operating levers, thrust pads and the abutment edges of shoes.

Hydraulic Components

Before disconnecting or removing any hydraulic pipe or component the area around the connections affected should be thoroughly cleaned and, once such a disconnection is made, the exposed pipe end and connecting point must immediately be suitably sealed against the entry of dirt into the system.

Before reassembly all hydraulic brake parts should be washed thoroughly in commercial alcohol, methylated spirit or approved brake fluid to ensure that all foreign matter is removed.

CAUTION: Any foreign matter which finds its way into the hydraulic system may score the pistons or damage the seals and render the brakes either partly or even wholly inoperative.

Do not use petrol, paraffin, carbon tetrachloride or any other mineral oil based solvent for cleaning any part of the hydraulic system. The slightest trace of such fluids can soon render the brakes inoperative by causing swelling and deterioration of the rubber seals.

Commercial alcohol or methylated spirit must always be used when flushing out the system, washing brake assemblies or their components and any container used for holding brake fluid.

All cylinders, pistons and piston seals should be protected from grease, oil and dirt during storage and all such parts, whether they are used or new and just drawn from stock, must be carefully examined before fitting.

When inspecting seals they must not be turned inside out as this would strain the surface skin of the rubber and lead to premature failure in service. The acceptance requirements are that the sealing lips are perfectly formed, concentric with the bore of the seal and free from knife edges, surface cracks, blemishes or other irregularities.

When inspecting cylinders and pistons the acceptance requirements are that they must be free from scores, ridges, steps, sharp edges, burrs or any other imperfections in or on their working or mating surfaces.

CAUTION: Any irregularity, however minute, in the seals, pistons or cylinders may form a track for fluid leakage under pressure and render the brakes inoperative. Therefore any part found to contain a visible imperfection must be rejected. It is also important that all parts are handled very carefully at all times, particularly after examination, to reduce the possibility of causing accidental scoring or other damage.

Before assembling hydraulic components always immerse them in clean approved brake fluid to ease their fitting and to provide initial lubrication for the working surfaces.

After completing any operation which involves the disconnection or replacement of any hydraulic component, the hydraulic system must be bled as described in operation 12 141.

Asbestos

WARNING: ASBESTOS DUST IS DANGEROUS TO HEALTH IF INHALED. Because of the injurious nature of asbestos dust as found in brake drums it must not be 'blown-out' with an air line. A vacuum cleaner, brush or rag must be used with care to remove any dust from brake drums. Any process which involves such requirements as cutting, filing or machining of asbestos materials must be carried out using suitable extraction equipment or with the use of a face mask or other similar personal protective equipment. Dust from any such operation should be collected in a sealed bag for disposal.

Cleaning equipment to suit these conditions can be obtained from:—

B. T. Sales and Service Ltd.
Huntingtower Road,
Sheffield S11 7GR
England.

17. Bleed the rear wheel brake assemblies as follows:
 - (a) ensure that the brake fluid reservoirs are full to the correct level
 - (b) remove any dust cap from the bleed valve on the rear wheel brake cylinders.
 - (c) use the same procedure as for the front brake assemblies.
18. Bleed the brake fluid reaction valve as follows:
 - (a) ensure that the brake fluid reservoirs are full to the correct level
 - (b) remove any dust caps from the reaction valve bleed valves
 - (c) connect the bleed tube onto the reaction valve bleed valve
 - (d) continue with the same procedure as for the front brake assemblies.

To Install

NOTE: Ensure that the brake shoe lining material of the replacement shoes is correct (see specifications). Check the code on the side of the brake shoe lining.

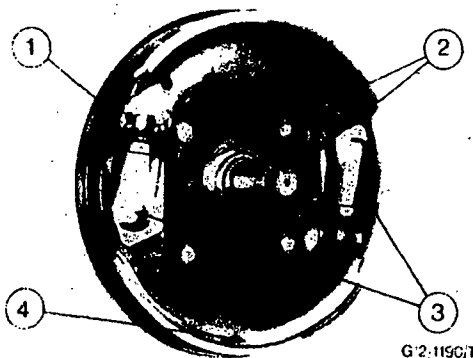
9. Fit the brake shoe return spring to both brake shoes.
10. Locate the leading end of the uppermost brake shoe into the wheel brake cylinder piston and its trailing end in the abutment.
11. Using the brake shoe horn (Tool No. 64947016) carefully lever the leading end of the other brake shoe into the wheel brake cylinder piston and then lever the trailing end of the brake shoe into the abutment slot in the other cylinder.
12. Ensure that the brake shoes are central and refit the wheel, hub and drum assembly as described in operation 14 363.

12 283 SHOES — FRONT BRAKE — REMOVE AND INSTALL (ONE SIDE) (INCLUDES ADJUST BOTH SIDES)

WARNING: When the brake drums are removed there is a certain quantity of dust around the brake shoes and inside the brake drums. This dust contains asbestos and is dangerous if inhaled. Care must be exercised in the removal of this dust. Do NOT use an air line to blow away the dust. Use a vacuum cleaner. If a vacuum cleaner is not available use protective breathing equipment and remove the dust with a brush or rag. Collect the dust in a sealable plastic bag for disposal.

HLS/S TYPE FRONT BRAKE ASSEMBLY**To Remove**

1. Ensure that the parking brake has been applied.
2. Place a jack under the centre of the front axle and raise the vehicle to enable axle stands to be placed under each end of the axle.
3. Lower the jack until it just supports the axle.
4. Using a wheel trolley, remove the wheel, hub and drum assembly as described in operation 14 363.
5. Prise one of the brake shoes from its abutment on the wheel brake cylinder using brake shoe horn tool (Tool No. 64947016).
6. Gradually release the brake shoe so that the other brake shoe can also be removed.
7. Remove both the brake shoes together with their brake shoe return springs.
8. Disconnect the brake shoe return springs from the brake shoes (see illustrations).

**HLS/S Front Brake Assembly**

- | | |
|------------------------|--------------------|
| 1. Brake Shoe Adjuster | 3. Wheel Cylinders |
| 2. Return Spring | 4. Brake Shoe |

8006 1275

PQ

13. Slacken-off the brake shoe steady post locknuts using the special adjuster tool (Tool No. 64927026). Unscrew each steady post by two full turns.
14. Turn the wheel brake adjusters in a clockwise direction until the brake shoes lock the brake drum.
15. Screw in one brake shoe steady post until it contacts the brake shoe web, and tighten the locknut using the special adjuster tool (Tool No. 64927026).
16. Repeat the adjustment operations for the second brake shoe steady post.
17. Readjust the wheel brake assembly as detailed by operation 12 132.
18. Raise the jack sufficiently to remove the axle stands. Remove the axle stands and lower the jack.
7. Place a wire, string or rubber band around the brake shoe expander tappets to prevent the rollers and wedge from falling out.
8. Hold the lower brake shoe and carrier and remove the carrier return springs.
9. Remove both brake shoes and carriers.
10. Note the brake lining material code and marking on the side of the brake lining.

12 285 SHOES — REAR BRAKE — REMOVE AND INSTALL (ONE SIDE) (INCLUDES REMOVE AND INSTALL WHEEL AND ADJUST BOTH SIDES)

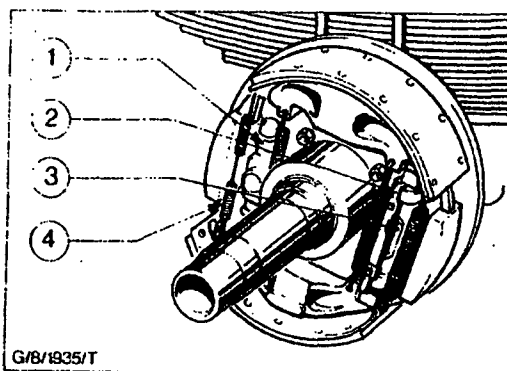
WARNING: When the brake drums are removed there is a certain quantity of dust around the brake shoes and in the brake drums. This dust contains asbestos and is dangerous if inhaled. Care must be exercised in the removal of the dust. Do not use an air line to blow the dust away. Use a vacuum cleaner. If a vacuum cleaner is not available use protective breathing equipment and remove the dust with a brush or rag. Collect the dust in a suitable plastic bag for removal.

H2L/S TYPE REAR BRAKE ASSEMBLIES

To Remove

NOTE: See illustrations for location of parts.

1. Chock the front wheels.
2. Place a jack under the rear axle and raise the vehicle sufficiently to enable axle stands to be placed under the rear axle at each end in the area within the spring 'U' bolts. Release the parking brake.
3. Remove the axle shaft as described in operation 15 322.
4. Place a wheel trolley in position under the wheels. Use a hub nut wrench (Tool No. 15 513A or 15 514B) to unscrew the hub bearing locknut. Remove the scalloped washer and the bearing adjusting nut. Remove the wheel, hub and drum assembly with the outer bearing cone.
5. Turn the rear wheel brake shoe adjusters in an anti-clockwise direction a few turns to slacken-off the brake shoes (see illustration).
6. Remove the brake shoe return springs using the special tool (Tool No. 64927926) or a suitable hook tool which locates in the eyelet of the return springs (see illustration).



G/B/1935/T

H2L/S Rear Brake Assembly

- | | |
|------------------|-------------------|
| 1. Expander Unit | 3. Wheel Cylinder |
| 2. Adjuster Unit | 4. Return Spring |



G 8-1857/T

Removing the Brake Shoe Return Springs

1. Hooked Special Tool No. 64927026
2. Return Spring

8006 1276

PQ

SERVICE AND REPAIR OPERATIONS**Precautions**

- (a) Tilting the cab.
ALWAYS use the specified cab tilting procedure which is detailed in Section 44 00.
- (b) Jacking up the vehicle.
When jacking up the vehicle, using a hydraulic bottle jack, ensure the vehicle is on firm, level ground, the brakes are applied and the wheels are chocked. The jack must be positioned at the correct jacking points, which are inboard of the 'U' bolt clamps on the relevant side of the rear axle or under the lower leaf spring on the front axle.
- (c) Methyl alcohol used in the alcohol evaporator is injurious to health and proper care must be exercised when handling.
- (d) Asbestos brake lining dust can be injurious to health if inhaled. Any dust found in the brake drum must be removed by using a vacuum cleaner or soft brush. Do not blow the dust out using a compressed air supply. The dust should be collected in a sealed bag for disposal.
- (e) ALWAYS change brake shoes in axle sets. Do not renew shoes on one side of an axle only or unequal braking will occur.
- (f) ALWAYS clean the brake backplates before installing brake assemblies, and lightly lubricate the steady posts, operating levers, thrust pads, and abutment edges of the shoes with high melting point grease.
- (g) ALWAYS disconnect the battery before commencing repair operations.
- (h) ALWAYS reset the tachograph clock (where fitted) after reconnecting the battery.
- (i) ALWAYS refer to the applicable procedure when undertaking service and repair operations.

- 4. Tighten the union and check that an unbroken line of sealant is visible around the joint. A broken line indicates that the quantity of sealant applied is insufficient.

B. P.T.F.E. (Polytetrafluoroethylene) Tape (Ford Specification SM 4G 1019A)

NOTE: This method of sealing should be used only if Loctite 572 is not available.

- 1. Thoroughly clean the threads of the union and mating component to remove traces of old sealant and dirt.
- 2. Apply the tape to the male thread, ensuring the tape is overlapped when pulled tight.
- 3. Screw the union into the component and tighten.

Joint Sealing

When any component of the braking system has been removed and the air lines disconnected, the following procedure must be observed for applying sealant to the threads of the union when the line is reconnected.

Two methods of sealing are available with Loctite 572 being the preferred method.

A. Loctite 572 (Ford Specification SJM 46 9102A)

- 1. Thoroughly clean the threads of the union and mating component to remove traces of old sealant and dirt.
- 2. Screw the union into the mating component by approximately two turns.
- 3. Smear the threads of the union with Loctite 572 and screw the union fully into the component.

12 132 BRAKES — ADJUST

Front and Rear

1. Chock the wheels, jack up the vehicle and fit stands. Release the park brake.
2. Spin the wheel and check that the bearings are free running.
3. Ensure that brake drums are cold. Turn the adjuster clockwise, whilst turning the wheel in the normal direction of rotation, until the shoes are in firm contact with the drum, preventing the wheel from being rotated.
4. Back-off the adjuster anti-clockwise until the shoes are just clear of the drum and the wheel can be rotated freely without binding.
5. Repeat the adjustment for the remaining wheels.
6. Remove the stands and lower the vehicle to the ground.



Front Brake Adjuster

1. Adjuster.

12 283 BRAKE SHOES — FRONT BRAKE — REMOVE AND INSTALL

To Remove

WARNING: Brake lining dust is injurious to health if inhaled and proper care must be taken when cleaning the brake drums and/or brake backplates.

1. Disconnect the battery earth (—) cable, chock the wheels, jack-up the vehicle and fit stands.
2. Slacken off the brake adjusters, and wind out and remove the spring brake release bolt.
3. Using a wheel trolley, remove the wheel and brake drum assembly as one unit, as detailed in Operation J4 371.
4. Using Girling Tool No. 649 47016 lever the lower end of the shoe from the adjuster, pull the shoe from the backplate to clear the adjuster and release the shoe. Both shoes can now be removed together with the springs.
5. Wire the tappets to keep them retracted.
6. Note the position of the retracting springs and remove the springs from the shoes. Remove the spring clips and bellcrank pivot pins, releasing the strut. Remove the strut from the shoes.

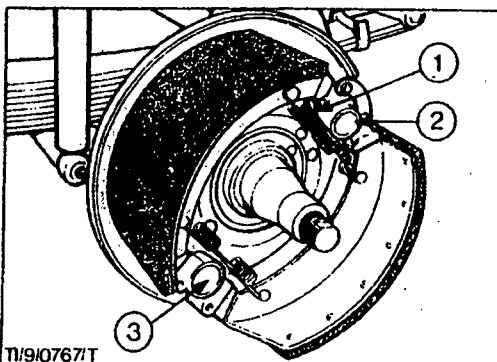


Rear Brake Adjuster

1. Adjuster.

To Install

7. Refit the bell crank struts and pivot pins to the upper brake shoes. Refit the spring clips, noting that the central tongue of the clip tensions the bell cranks against the struts.



T1/9/0767/T

Front Brake Assembly

1. Retracting spring.
2. Expander.
3. Adjuster.

PQ

8. Refit new inner retracting springs across the shoes. The leading edge of each lining must be chamfered and be fitted diametrically opposite that of the other shoe.
9. Fit the brake shoes and springs to the back plate with the leading edges of the shoes against the direction of rotation. Remove the retaining wire from the tappets.

NOTE: On each shoe, the lining stops short of the leading end of the shoe, and in the portion not covered by the lining there is an aperture for access to the bell crank adjuster.

10. Ensure that the shoes are correctly located on the expander and the adjuster. Fit the new outer brake shoe retracting springs. Check that the yellow pair of springs are fitted to the ends of the brake shoes adjacent to the expander and the orange pair adjacent to the adjuster.
11. Ensure the expander tappet for the secondary shoe is fully home in the housing (the circlip will be almost touching the housing) and adjust the bell crank lever adjuster to give the specified clearance between the shoe tip (leading edge) and the expander tappets.
Check the clearance using feeler gauges. Hold the bell crank adjuster and tighten the locknut to the specified torque value.
12. Ensure that the brake shoe adjuster is fully released. Remove any dust and dirt from the assembly.
13. Refit the wheel and brake drum assembly as detailed in Operation 14 371, taking care not to damage the brake linings.
14. Adjust the brake shoes as detailed in Operation 12 132. Refit the spring brake release bolt and tighten to the specified torque.
15. Remove the axle stands and lower the vehicle. Reconnect the battery earth (-) cable.

12 285 BRAKE SHOES — REAR BRAKE — REMOVE AND INSTALL

To Remove

WARNING: Brake lining dust is injurious to health and proper care must be taken when cleaning the brake drums and/or brake back plates.

1. Disconnect the battery earth (-) cable, chock the wheels, jack up the vehicle and fit stands.
2. Slacken off the brake adjusters and wind out and remove the spring brake release bolt.
3. Unscrew the nuts from the axle shaft bolts, and withdraw the axle shaft, oil baffle, and gaskets.
4. Place a suitable wheel trolley in position under the wheels.
5. Using socket (Tool No. C-1041), remove the bearing locknut, lockwasher and bearing adjuster nut. Withdraw the wheel and hub assembly complete with the outer bearing cone.

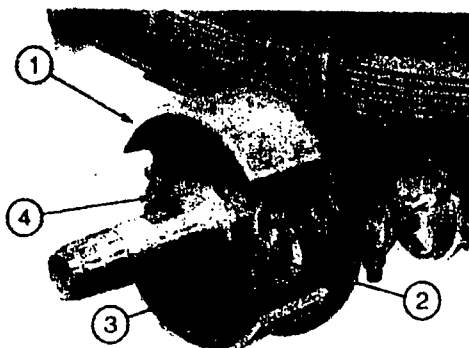
6. Lever the lower shoe away from the expander, turn the shoe away from the backplate and release the shoe; the shoes can now be removed together with the retracting springs.
7. Fit a clip or wire round the expander tappets to keep them retracted.
8. Detach the retracting springs from the bell crank pivot pins. Withdraw the spring clips and remove the pivot pins, bell cranks and struts.

To Install

9. Refit the bell crank struts and pivot pins to the new shoes with the adjustable cranks at the leading edges.

NOTE: The leading edge of each lining must be chamfered. On each shoe, the lining stops short of the leading edge of the shoe, and in the portion not covered by the lining there is an aperture for access to the adjuster.

10. Fit new spring clips to retain the bell crank pivot pins in each shoe.
11. Set the shoes with the leading edges diametrically opposite each other and connect new inner retracting springs.



G17/0314/T

Rear Brake Assembly

1. Brake shoe.
2. Expander.
3. Retracting springs.
4. Adjuster.

3. Remove all the asbestos clutch lining dust from the clutch pressure plate, the clutch disc and the flywheel.

WARNING: Asbestos dust is injurious to health and must not be inhaled. Do not blow the dust off with an air line. Use a suitable vacuum cleaner. If a vacuum cleaner is not available, use personal protective breathing equipment or a suitable face mask and remove the dust carefully with a brush or rag. Collect the dust in a sealable plastic bag or envelope for disposal.

4. Inspect the pressure plate assembly generally for damaged or worn parts. In particular check the friction surface for scoring, discolouration or cracks.
5. (a) On the axial spring clutch check the operating lever ends for wear. Check also for broken coil springs.
- (b) On the diaphragm spring clutch check the diaphragm spring for cracks or broken sectors and for excessive wear on the ends of the sectors at the centre.
- (c) If these or any other defects are present, replace with a new pressure plate assembly.
6. Inspect the clutch disc for wear on the friction linings, check to see if they are worn down near to the rivet heads. Check the linings as well for oil contamination. Check the buffer springs for cracks or breakage and also that they are not loose in the housings. If these or any other defects are present, replace with a new clutch disc.
7. Inspect the flywheel friction surface for scoring, discolouration or cracks. If the flywheel is unserviceable fit a new part as detailed in operation 21 582 4.

To install

8. Lightly grease the splines in the clutch disc hub.

CAUTION: Only the very slightest film of grease should be applied as any excess will be thrown out and may contaminate the friction linings.

9. Place the clutch disc in position on the flywheel with the shortest spligot of the splined hub towards the flywheel. Place the clutch disc/flywheel pilot bearing alignment tool in position. Select an alignment tool according to clutch disc diameter:

305 mm (12 in) diameter clutch: Tool No. C-7088

330 mm (13 in) diameter clutch: Tool No. 16515

10. Place the pressure plate in position and hold it against the clutch disc. On vehicles fitted with the 330 mm (13 in) diameter clutch (axial or diaphragm spring) ensure that the dowels in the flywheel are aligned with the dowel holes in the clutch pressure plate cover.
11. Enter all the securing bolts together with new lockwashers and screw them in until they are all just lightly clamping the pressure plate.
12. Screw in each bolt one turn at a time to carefully and evenly pull the pressure plate up to the flywheel and load the pressure plate springs. Ensure that the dowels engage correctly with the dowel holes. Finally tighten the bolts to the specified torque (see specifications).
13. Remove the disc alignment tool.

Ford and Cummins V8 Engine Models

To Remove

1. Clutch housing removed, refer to operation 16 784 4.
2. Slacken and unscrew evenly and gradually the bolts retaining the clutch pressure plate to the flywheel. Remove the bolts, the pressure plate, the first clutch disc, the intermediate plate and the second disc.
3. Remove all the asbestos clutch lining dust from the clutch pressure plate, the two discs, the intermediate plate and the flywheel.



Aligning the Clutch Disc Splines with the Flywheel Pilot Bearing

1. Alignment Tool.

WARNING: Asbestos dust is injurious to health and must not be inhaled. Do not blow the dust off with an air line. Use a suitable vacuum cleaner. If a vacuum cleaner is not available, use personal protective breathing equipment or a suitable face mask and remove the dust carefully with a brush or rag. Collect the dust in a suitable plastic bag or envelope for disposal.

4. Inspect the pressure plate assembly generally for damaged or worn parts. In particular check:

- (a) the friction surface for scoring, discolouration or cracks,
- (b) the operating lever ends for wear,
- (c) for broken coil springs.

If these or any other defects are present, replace with a new pressure plate assembly.

5. Inspect the intermediate plate for scoring, discolouration or cracks. Check also the centralising leaf springs for cracks or breakage. If these or any other defects are present replace with a new intermediate plate.
6. Inspect the two clutch discs for wear on the friction linings. Check to see if the linings are worn down nearly to the rivet heads. Check the linings for oil contamination. Check the buffer springs for cracks or breakage and also that they are not loose in the housings. If these or any other defects are present replace one or both clutch discs as necessary with a new part.
7. Inspect the flywheel friction surface for scoring, discolouration or cracks. If the flywheel is unserviceable fit a new part as detailed in operation 21 582 4.

To install

8. Lightly grease the splines in the hub of both clutch discs.

CAUTION: Only the very slightest film of grease should be applied as any excess will be thrown out and may contaminate the friction linings.

9. Place the spigot end of the clutch disc/flywheel pilot bearing alignment tool (Tool No. C-7139) in the flywheel pilot bearing.
10. Place one of the clutch discs on the alignment tool with the longest spigot of the splined hub towards the flywheel. Slide the disc up against the flywheel.

11. Place the intermediate plate in position against the first disc with the four driving lugs engaged in the four driving slots on the flywheel and the centralising leaf springs on each lug in a trailing position relative to flywheel rotation. Slide the plate up against the first disc. Take note of the position of the letter 'L' stamped on the plate.
12. Place the second clutch disc on the alignment tool with the longest spigot of the splined hub towards the flywheel. Slide the disc up against the intermediate plate.
13. Hold the clutch pressure plate in position against the second disc with the letter 'H' stamped on the cover as near as possible to the letter 'L' on the intermediate plate. Ensure that the dowels in the flywheel are aligned with the dowel holes in the clutch pressure plate cover.
14. Enter all the securing bolts with new lockwashers and screw them in until they are just lightly clamping the pressure plate.
15. Screw in each bolt one turn at a time to carefully and evenly pull the pressure plate up to the flywheel and load the pressure plate springs. Ensure that the dowels engage correctly with the dowel holes. Finally tighten the bolts to the specified torque (see specifications).
16. Remove the disc alignment tool.

16 784 4 CLUTCH HOUSING — REMOVE AND INSTALL (Transmission Removed)

In-Line Diesel Engine Models

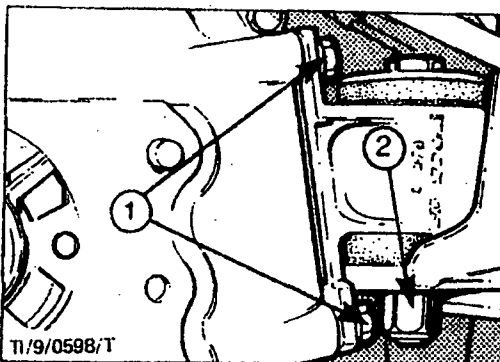
To Remove

1. Tilt the cab as described in section 44.
2. Slacken, unscrew and remove the two bolts securing the clutch slave cylinder. Do not remove the push rod or the rubber boot from the slave cylinder. Swing the cylinder aside and suitably support it to prevent damage to the hydraulic fluid line.

NOTE: On all vehicles fitted with four (4-410-S), six and eight speed transmissions, the slave cylinder is mounted on a cast extension bracket on the clutch housing. On vehicles fitted with the Ford 4-310 transmission the slave cylinder is mounted on a flange on the clutch release arm.

3. Remove the battery cover and disconnect the batteries.

4. On vehicles fitted with 4-310 transmission, unhook and remove the clutch release arm return spring from the bracket on the clutch housing and the lug on the arm.
 5. Place a suitable jack under the clutch housing portion of the sump and support the engine.
 6. Slide the clutch release bearing and hub assembly off the fingers of the release arm fork and withdraw the bearing and hub assembly via the transmission main drive shaft aperture in the clutch housing.
 7. Press the clutch release bearing off the hub.
 8. Slacken, unscrew and remove the self locking nut and the centre bolt from the engine right-hand rear mounting.
 9. Slacken, unscrew and remove the four bolts securing the engine right-hand rear mounting bracket to the clutch housing and withdraw the bracket.
 10. Slacken, unscrew and remove the four bolts securing the engine left-hand rear mounting bracket to the clutch housing.
 11. Slacken, unscrew and remove the fifteen bolts securing the clutch housing to the engine. Move aside any cables or pipes that were clipped to the housing. Pull the housing off the two locating dowels and lower it to the floor. Move the housing away from the vehicle.
 12. Remove all the asbestos clutch lining dust from the clutch housing.
- WARNING: Asbestos dust is injurious to health and must not be inhaled. Do not blow the dust off with an air line. Use a suitable vacuum cleaner. If a vacuum cleaner is not available, use personal protective breathing equipment or a suitable face mask and remove the dust carefully with a brush or rag. Collect the dust in a sealable plastic bag or envelope for disposal.**
13. Remove the clutch release arm rubber gaiter from the clutch housing aperture and pull it off the release arm.
 14. Pull the clutch release arm to disengage it from the trunnion pivot ball and remove the arm from the housing.
 15. Slacken, unscrew and remove the release arm pivot trunnion ball from the clutch housing.
 16. On vehicles fitted with the Ford 4-310 transmission, slacken the clutch release arm free play adjusting screw locknut. Unscrew and remove the adjusting screw from the housing.
 17. Thoroughly wash and clean all component parts. Discard the old rubber gaiter, self locking nuts and all lockwashers.
 18. Inspect all parts for excessive wear or damage. Replace all unserviceable parts with new parts.
- To install**
19. On vehicles fitted with the Ford 4-310 transmission, screw the clutch release arm free play adjusting screw and locknut assembly into its location in the clutch housing.
 20. Screw the release arm pivot trunnion ball into its location inside the clutch housing together with a new lockwasher and tighten to the specified torque (see specifications).
 21. Place a smear of grease on both the pivot trunnion ball and in the ball socket in the release arm. Lift the retaining spring clip with a screwdriver and slide the arm over the ball until the ball is entered securely in the socket. Release the retaining spring clip.
 22. Pull a new release arm rubber gaiter over the arm and position the gaiter groove on the rim of the clutch housing aperture.
 23. Press the clutch release bearing onto the hub.



Engine Rear Mounting Bracket

1. Rear mounting bracket bolts.
2. Rear mounting centre bolt.

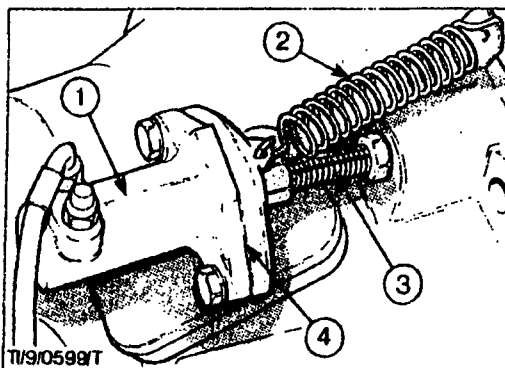
Petrol Engine Models

1. Tilt the cab as described in section 44.
2. On vehicles fitted with four (4-410-S), six and eight speed transmissions, slacken, unscrew and remove the two bolts securing the clutch slave cylinder to the clutch housing. Do not remove the push rod or the rubber boot from the slave cylinder. Swing the cylinder aside and suitably support to prevent damage to the hydraulic fluid line.
3. Remove the battery cover and disconnect the batteries.
4. Slacken, unscrew and remove the nut securing the starter motor electrical lead to the starter motor and disconnect the lead.
5. Slacken, unscrew and remove the two bolts securing the starter motor and remove the starter motor.
6. Slacken, unscrew and remove the four bolts securing the flywheel lower front cover and remove the cover.
7. On vehicles fitted with the 4-310 transmission, slacken, unscrew and remove the five bolts securing the clutch housing bottom cover and remove the cover.
8. Slide the clutch release bearing and hub assembly off the fingers of the release arm fork and withdraw the bearing and hub assembly via the transmission's main drive shaft aperture in the clutch housing.
9. Press the clutch release bearing off the hub.
10. Place a suitable jack under the sump at the rear of the engine with a piece of soft timber between the jack and the sump. Raise the jack to take the weight of the engine.
11. Slacken, unscrew and remove the self locking nut from the clutch housing to chassis cross member mounting bolt on each side of the housing. Withdraw the bolts together with the flat washers, lower insulators and the distance tubes.
12. Slacken, unscrew and remove the six bolts securing the clutch housing to the engine. Move aside any cables or pipes that were clipped to the housing. On vehicles fitted with the 4-310 transmission the two bolts on the left-hand side also retain the clutch slave cylinder. Move the cylinder aside and suitably support to prevent damage to the hydraulic pipe.

13. Raise the jack slightly to lift the housing lugs off the upper insulators.
14. Pull the clutch housing off the two locating dowels and lower it to the floor. Remove the two upper insulators from the cross member pads. Move the housing away from the vehicle.
15. Remove all the asbestos clutch lining dust from the clutch housing.

WARNING: Asbestos dust is injurious to health and must not be inhaled. Do not blow the dust off with an air line. Use a suitable vacuum cleaner. If a vacuum cleaner is not available, use personal protective breathing equipment or a suitable face mask and remove the dust carefully with a brush or rag. Collect the dust in a sealable plastic bag or envelope for disposal.

16. On vehicles fitted with the 4-310 transmission, unhook the clutch release arm return spring from the lug on the housing and from the lug on the arm and remove the spring.
17. Remove the clutch release arm rubber gaiter from the clutch housing aperture and pull it off the release arm.
18. Pull the clutch release arm to disengage it from the trunnion pivot ball and remove the arm from the housing.
19. Slacken, unscrew and remove the release arm pivot trunnion ball from the clutch housing.



Release Arm and Slave Cylinder Assembly — 4-310 Transmission

- | | |
|-------------------------------|-------------------------------|
| 1. Hydraulic slave cylinder. | 3. Free-play adjusting screw. |
| 2. Release arm return spring. | 4. Release arm. |

40. On vehicles fitted with four (4-410-S), six and eight speed transmissions, place the clutch slave cylinder in position on the clutch housing cast bracket ensuring that the push rod engages correctly with the clutch release arm. Screw in the two retaining bolts together with new lockwashers and tighten to the specified torque (see specifications).
41. Pass the release bearing and hub assembly through the transmission main drive shaft aperture in the clutch housing and slide it into position on the release arm fork.
42. Lower the cab as described in section 44.
4. Slacken, unscrew and remove the union adaptor from the release bearing hub. Press the bearing off the hub.
5. Slacken, unscrew and remove eleven of the twelve bolts securing the clutch housing to the engine leaving one bolt at the top. Move aside any cables or pipes that were clipped to the housing.
6. Hold the housing, slacken, unscrew and remove the final top bolt and lower the clutch housing to the floor. Remove the housing from the vehicle.
7. Remove all the asbestos clutch lining dust from the clutch housing.

Ford and Cummins V8 Diesel Engined Models

To Remove

1. Tilt the cab as described in section 44.
2. (a) On vehicles fitted with a hydraulic clutch slave cylinder slacken, unscrew and remove the two bolts securing the clutch slave cylinder to its mounting block on the clutch housing. Do not remove the push rod or the rubber boot from the slave cylinder. Withdraw the cylinder and push rod assembly from the mounting block, swing the cylinder aside and support it to prevent damage to the hydraulic fluid line.
- (b) On vehicles equipped with an air assisted clutch slave cylinder slacken, unscrew and remove the two bolts securing each trunnion in the slave cylinder mounting bracket on the clutch housing. Withdraw the two trunnions and remove the slave cylinder and the two side packing washers from the clutch housing. Swing the slave cylinder aside and support it to prevent damage to the hydraulic fluid and air lines.

NOTE: Before removing the air assisted clutch slave cylinder on vehicles with the Cummins V8 engine it may necessary to move that part of the fuel return system adjacent to the slave cylinder upper trunnion. If this is necessary plug all open fuel lines.

3. Withdraw the clutch release bearing and hub assembly from the clutch housing via the transmission main drive shaft aperture. Slacken, unscrew and disconnect the grease lubrication pipe union nut on the release bearing hub and remove the bearing and hub assembly.

WARNING: Asbestos dust is injurious to health and must not be inhaled. Do not blow the dust off with an air line. Use a suitable vacuum cleaner. If a vacuum cleaner is not available, use personal protective breathing equipment or a suitable face mask and remove the dust carefully with a brush or rag. Collect the dust in a sealable plastic bag or envelope for disposal.

8. Slacken and unscrew the union on the release bearing grease lubrication pipe at the grease nipple end and remove the pipe.
9. Slacken, unscrew and remove the two grease nipples on the side of the housing.
10. Remove the clutch release arm rubber gaiter from the clutch housing aperture and pull it off the release arm.
11. Pull the clutch release arm to disengage it from the trunnion pivot ball and remove the arm from the housing.
12. Slacken, unscrew and remove the release arm pivot trunnion ball from the clutch housing.
13. On vehicles with the hydraulic slave cylinder slacken, unscrew and remove the two bolts securing each trunnion in the slave cylinder mounting cast bracket on the clutch housing. Withdraw the two trunnions and remove the slave cylinder mounting block.
14. Thoroughly wash and clean all component parts. Discard the old rubber gaiter and all lockwashers. Inspect all parts for excessive wear or damage. Replace all unserviceable parts with new parts.

PQ

Service

Rear Suspension

Lubricate the shackle pins using the specified grease through the two grease nipples on each rear spring. On four spring tandem vehicles, lubricate the shackle pins using the specified grease through the six grease nipples (see illustration). No lubrication is required on twin spring tandem vehicles.

ABCD Grease compensating tube pins/suspension arm brackets (four spring bogie only).

Lubricate the compensating tube pins using the specified grease through the grease nipple located on each compensating tube pin.

BCD Check battery terminals: clean and grease.

Clean the connecting faces of the battery terminal posts and clamps to a bright surface with abrasive paper. Apply a thin film of petroleum jelly (not grease) to the terminal connections.

ABCD Grease cab hinges and locking mechanism.

The two cab hinges are located behind the front grille access panel and lubricated through the grease nipple on each hinge using the specified grease. Smear the cab locking mechanism, located at the rear of the cab with the specified grease.

ABCD Lubricate door locks, cylinders and catches, hinges and check straps. Ensure all the door lock and hinge components are lubricated with the specified oil and/or grease.

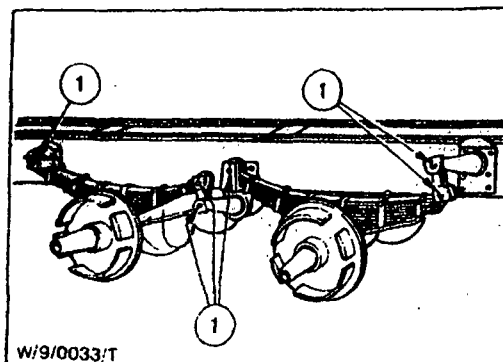
Service

CD Check brake linings for wear and contamination.

WARNING: Brake lining dust is injurious to health if inhaled and adequate safety precautions must be observed when cleaning the brake drums and/or backplates.

Chock the wheels, jack up the vehicle and fit the axle stands. Slacken off the brake adjusters and remove the wheel and brake drum assembly as detailed in Operation 14 371. Examine the brake linings for evidence of contamination by oil, grease or other harmful substances. Check the linings for excessive wear. If the lining thickness is considered inadequate for the next service period, it must be reported and the service form endorsed.

NOTE: Following completion of all Maintenance Procedures that necessitate removal of the wheel and brake drum assembly, the assembly must be refitted and ALL the brakes adjusted as detailed in Operation 12 132.



W/9/0033/T

Rear Spring -- Lubrication (4 Spring Tandem)

1. Grease nipples.

Service

ABCD Check exhaust smoke.

With the engine running under load, check the exhaust smoke.

Refer to the engine or fuel system sections of this manual for the exhaust smoke remedial procedures.

ABCD Check that all brakes operate efficiently.

The test should be carried out preferably on a dry, clean and reasonably smooth and level road, with the vehicle laden to a minimum of 75% GVW/GCW. Articulated vehicles should be tested with a trailer of known performance.

Test the brakes at several speeds within the normal operating range with light and heavy pedal pressure.

Allow the vehicle to coast to check for brake drag and tendency to pull to one side.

Check brake drum temperature to ascertain if any drum is binding, if one drum is binding it will be hotter than the others.

WARNING: Hot brakes may smoke; avoid inhaling the fumes as they may contain asbestos dust which is injurious to health.

NOTE: The above road test should not be carried out until the braking system components are correctly 'bedded in' from new. Newly fitted brake linings and/or brake drums will not reach peak efficiency until the 'bedding in' process is complete.

If necessary, refer to the fault diagnosis in Section 12 of this manual to diagnose and rectify any fault.

ABCD Check all instruments and controls.

Ensure that all instruments and controls function satisfactorily, including the tachograph, tachometer and/or speedometer, whichever is fitted.

Check that the air pressure gauge(s) register the specified operating pressure when the engine is running.

Check that the low pressure warning buzzer operates when the air pressure in the system falls below the specified value.

Service

Check that the oil pressure gauge registers the specified pressure during normal operating speeds.

Check that the warning lights illuminate when required. Ensure the direction indicator warning light self-cancels when the steering wheel is returned to the straight ahead position.

ABCD Check circuit test switches.

On vehicles fitted with hydraulic brake systems a brake pressure differential warning light and test switch may be incorporated and located adjacent to the lower switch panel. To check the circuit depress the switch and check that the red light illuminates. The light will remain extinguished if the bulb has failed.

WARNING: If the light illuminates at any other time a faulty braking system is indicated. The vehicle must not be driven until the fault has been rectified.

ABCD Check interior lights.

Ensure that the interior light illuminates brightly when the switch is operated.

ABCD Check operation of door locks, latches and check straps.

Ensure that both doors open and close satisfactorily and that the check straps restrain the doors from excessive travel. Check that the locks function satisfactorily and that the latches hold the doors securely in their apertures. Adjust if necessary.

PRECAUTIONS

Resin Based Adhesives/Sealers

For example, epoxide and formaldehyde resin based.

Working should only be carried out in well ventilated areas as harmful or toxic fumes/chemicals may be released.

Contact with uncured resins and sealers can result in irritation, dermatitis, and absorption of toxic or harmful chemicals through the skin. Sealers can damage the eyes.

Provide adequate ventilation, and avoid skin and eye contact. Follow the manufacturer's instructions.

Resin Based, Cyanoacrylate and Other Adhesives

These are irritant, sensitizing or harmful to the skin. Some are eye irritants.

Skin and eye contact should be avoided and manufacturer's instructions followed.

Cyanoacrylate adhesives (super-glues) must not contact the skin or eyes. If skin or eye is bonded, cover with a clean moist cloth and get medical attention. Do not try to pull tissue apart. Use in well ventilated areas as vapours can cause irritation of the nose and eyes.

Two-pack systems see 'Resin Based Adhesives/Sealers'.

Urethane (Polyurethane) Adhesives/Sealers Resin Based Adhesives/Sealers

Individuals suffering from asthma or other respiratory allergies should not work with these materials as sensitivity reactions can occur.

Working should preferably be carried out in exhaust ventilated booths removing dust and spray droplets from the working zone. Individuals working with these applications should wear supplied air respirators.

Antifreeze - See Fire, Solvents

For example, isopropanol, ethylene glycol, etc.

HEALTH AND SAFETY PRECAUTIONS 05

Highly flammable, flammable, combustible.

Used in vehicle coolant systems, brake air pressure systems, screenwasher solutions.

Vapours given off from coolant antifreeze (glycol) arise only when heated.

Antifreeze may be absorbed through the skin in toxic or harmful quantities. If swallowed seek medical attention immediately.

ARC-WELDING - See Welding

ASBESTOS - See Brake and Clutch Linings and Pads

BATTERY ACIDS - See Acids and Alkalies

Gases released during charging are explosive. Never use naked flames or allow sparks near charging or recently charged batteries.

BRAKE AND CLUTCH FLUIDS (Polyalkylene Glycols) - See Fire

Combustible.

Splashes to the skin and eyes will be slightly irritating. Avoid skin and eye contact as far as possible. Inhalation vapour hazards do not arise at ambient temperatures because of the very low vapour pressure.

BRAKE AND CLUTCH LININGS AND PADS - See Legal Aspects

These items contain asbestos, which if inhaled may cause lung damage and in some cases, cancer.

The normal handling and fitting of these items should not cause any hazard, but any drilling, grinding or filing of friction materials may produce asbestos dust, and should only be carried out under strictly controlled conditions.

The dust in brake drums, etc. contains very little asbestos but care should be taken to avoid inhalation of this dust during servicing of brakes and clutches. The use of drum cleaning units, vacuum cleaning or damp wiping is preferred to the use of air jets for 'blowing-out'.

BRAZING - See Welding

CHEMICAL MATERIALS - GENERAL - See Legal Aspects

Chemical materials such as solvents, sealers, adhesives, paints, resin foams, battery acids, antifreeze, brake fluids, oils and grease should always be used with caution and stored and handled with care. They may be toxic, harmful, corrosive, irritant or highly flammable and give rise to hazardous fumes and dusts.

The effects of excessive exposure to chemicals may be immediate or delayed; briefly experienced or permanent; cumulative; superficial, life threatening; or may reduce life-expectancy.

DO'S

DO remove chemical materials from the skin and clothing as soon as practicable after soiling. Change heavily soiled clothing and have it cleaned.

DO carefully read and observe hazard and precaution warnings given on material containers (labels) and in any accompanying leaflets, posters or other instructions. Material health and safety data sheets can be obtained from Manufacturers.

DO organise work practices and protective clothing to avoid: soiling the skin and eyes; breathing vapours/aerosols/dusts/fumes; inadequate container labelling; fire and explosion hazards.

DO wash before job breaks, before eating, smoking, drinking or using toilet facilities when handling chemical materials.

DO keep work areas clean, uncluttered and free of spills.

DO store according to national and local regulations.

DO keep chemical materials out of the reach of children.

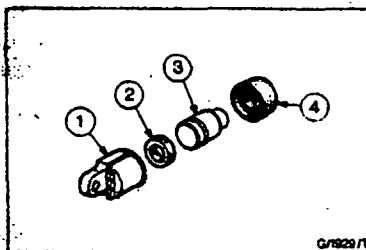
TRANSCO
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January 1983 Page 3

8006 1287

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12 BRAKING SYSTEM



Front Wheel Cylinder Assembly - Exploded (254 mm Diameter Brake)
1. Cylinder body 3. Piston
2. Seal 4. Dust Cover

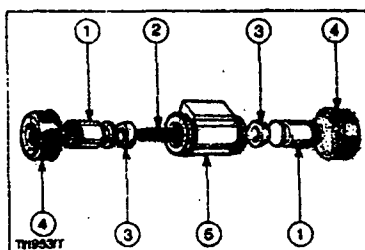
To Assemble

6. Fit a new seal in position, taking care not to damage the seal. Ensure it is correctly seated and positioned.
7. Lubricate the wheel cylinder bore, seal and piston with the specified brake fluid.
8. Insert the piston return spring into the cylinder.
9. Carefully push the piston into the bore, ensuring the seal is correctly seated.
10. Fit the dust cover after lubricating the inner contact surfaces with the specified red rubber grease.

REAR CYLINDER - REAR WHEEL - (Wheel Cylinder Removed)

1. Carefully remove the dust covers and pistons and seals.
2. Where applicable, remove the push rod from the dust covers.
3. Remove the seals from the pistons and the cylinder bore.
4. Clean the wheel cylinder bore and pistons with a wire brush, ridges, corrosion and dirt.
5. If either piston or seal is damaged in any way, a new wheel cylinder assembly must be fitted.
6. Clean all parts.

7. Fit a new seal in position, taking care not to damage the seal. Ensure it is correctly seated.



Rear Wheel Cylinder Assembly - Exploded (254 mm Diameter Brake)
1. Piston 4. Dust cover
2. Spring 5. Cylinder body
3. Seal

7. Lubricate the wheel cylinder bore, pistons and seals with the specified brake fluid.
8. Carefully push the pistons into the bore, ensuring the seals are correctly seated.
9. Lubricate the inner contact surfaces of the dust covers with the specified red rubber grease and fit them in position.
10. Where fitted, insert push rods into position.

12 311 PLATE - FRONT BRAKE CARRIER - REMOVE AND INSTALL (ONE SIDE) (INCLUDES BRAKE SYSTEM BLEED)

CAUTION: TO PREVENT POSSIBLE CONTAMINATION, THE BRAKE FLUID SHOULD ALWAYS BE USED DIRECT FROM THE SUPPLIER'S CONTAINER WHEREVER POSSIBLE. IF THIS IS NOT PRACTICABLE (i.e. WITH A 25 LITRE CONTAINER etc.) FROM THE FLUID SHOULD ONLY BE DRAWN INTO CONTAINERS WHICH ARE KEPT CLEAN AND CLOSED. NEVER USE A CONTAINER WHICH HAS BEEN OPENED OR AT ANY TIME IN CONTACT WITH AIR. IT IS MOST ESSENTIAL THAT THESE CONTAINERS ARE NOT ALLOWED TO BECOME CONTAMINATED BY DIRT OR BY ANY OTHER FLUIDS. WHEN THE SPECIAL CONTAINER DOES BECOME CONTAMINATED AND IT REQUIRES CLEANING THEN SUCH MINERAL CLEANING FLUIDS AS PETROL, PARAFFIN etc. MUST NOT BE USED UNDER ANY CIRCUMSTANCES. THE

CONTAINER SHOULD BE RINSED WITH CLEAN BRAKE FLUID AND CLEANED WITH A CLEAN, LINT FREE CLOTH OR WITH CLEANING FLUID. FLUID WHICH HAS BEEN DRAWN FROM A BRAKE SYSTEM OR HAS BEEN USED FOR CLEANING A CONTAINER MUST NEVER BE RE-USED. AT ALL TIMES PRECAUTIONS SHOULD BE TAKEN TO PREVENT THE INGRESS OF DIRT AND SAND TO THE SYSTEM, OTHERWISE DAMAGE TO THE SEALS AND SOLENOID COILS.

NOTE: Care must be taken to avoid damaging the wheel cylinder dust covers during strip down and assembly of the brake components.

To Remove

1. Apply the parking brake.
2. Loosen the wheel retaining nut so that a dial gauge can be fitted to adjust wheel bearing and 'toe' during reassembly as described in paragraph 12 403.
3. Remove the wheel bearing dust cap using the correct tool.
4. Use a screw jack to jack up the front of the vehicle.

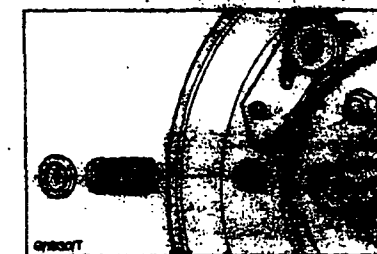


Front Wheel Bearing and Dust Cap Assembly

5. Loosen the wheel retaining nut so that a dial gauge can be fitted to adjust wheel bearing and 'toe' during reassembly as described in paragraph 12 403.
6. Remove the wheel bearing dust cap using the correct tool.
7. Remove the wheel bearing dust cap using the correct tool.
8. Remove the wheel and clean using a wheel brush. Avoid damage to the inner bearing grease seal.
9. Remove all asbestos dust from the brake drum.

A WARNING: ASBESTOS DUST IS EXTREMELY DANGEROUS AND SHOULD NOT BE INHALED. IT CAN CAUSE LUNG DISEASE. THE DUST CAP MUST BE REMOVED USING A DUST CAP REMOVAL TOOL. IF A VACUUM CLEANER IS NOT AVAILABLE, THE DUST MUST BE PROTECTED BY A SUITABLE PROTECTIVE COVERING OR A SUITABLE PROTECTIVE COVERING. REMOVE THE DUST CAP USING A BRUSH OR RAG. DO NOT USE DUST IN A SUITABLE PROTECTIVE COVERING.

10. Note the position of the dust cap and springs to ensure correct reassembly.
11. Remove the wheel bearing dust cap using the correct tool.



12 404 Dust Cap Assembly

12. Pull the dust cap and springs out of the wheel bearing dust cap.
13. Rotate the dust cap and springs to the correct position.
14. a) On 254 mm (10 in) diameter wheels, the dust cap and springs must be fitted to the wheel bearing dust cap.
15. On 254 mm (10 in) diameter wheels, the dust cap and springs must be fitted to the wheel bearing dust cap.
16. Unscrew the retaining bolts and remove the wheel cylinder from the carrier plate.

16 MANUAL TRANSMISSION AND CLUTCH

16-713 CLUTCH PEDAL FREE TRAVEL - ADJUST

To Adjust

1. Release the two jam nuts on the cable adjuster located behind the clutch pedal.



2. Adjust the cable to achieve the specified clearance.

3. Tighten the jam nuts.

16-724 CLUTCH DISC AND PRESSURE PLATE - REMOVE AND INSTALL (Engine or Transmission Removed)

To Remove

1. On Ford 4.310 transmissions remove the clutch housing.
2. Evenly uncrew the bolts retaining the clutch pressure plate to the flywheel.

Remove the pressure plate and disc assembly. **CAUTION: DUST IS HARMFUL TO EYES AND MUST BE REMOVED. DO NOT BLOW THE DUST OFF WITH AIR LINE. USE A VACUUM CLEANER. IF A VACUUM CLEANER IS NOT AVAILABLE, USE PERSONAL PROTECTIVE BREATHING EQUIPMENT OR A SUITABLE FACE MASK AND REMOVE THE DUST CAREFULLY WITH A BRUSH OR RAG. COLLECT THE DUST IN A SEALABLE PLASTIC BAG OR ENVELOPE FOR DISPOSAL.**

3. Inspect the clutch disc for loose facings, excessive wear, distortion or cracks from overheating, broken or loose springs and spring supports or contamination from oil or grease. Inspect the pressure plate for damage, particularly the spring surfaces and disc contact surfaces. The flywheel should also be inspected for wear or damage.

4. Remove damaged components as described in this manual. If a component is damaged, the entire clutch assembly must be replaced. If the flywheel is damaged, refer to operation 21-108.

5. The pressure plate and flywheel should be cleaned with Gunklone or Penetone Formula 80. If there are signs of oil or grease on the friction surfaces.

To Install

6. Lightly grease the splines of the clutch disc hub.

CAUTION: ANY EXCESS GREASE WILL BE THROWN ONTO THE FRICTION LINES.

7. Place the clutch disc on the flywheel. Align the disc with the pilot bearing using an installer tool (21-044).



Installing the Pressure Plate Assembly

1. Installer tool no. 21-044
2. Flywheel

8. Fit the pressure plate assembly locating it on the flywheel dowels. Screw in the retaining bolts with new spring washers. Tighten the bolts evenly to gradually pull the pressure plate into its location. Finally tighten the bolts to the specified torque.

9. Remove the installer tool.

10. Replace the clutch housing on 4.310 transmissions.

MANUAL TRANSMISSION AND CLUTCH 16

16-814 CABLE - CLUTCH OPERATING - REMOVE AND INSTALL

To Remove

1. Loosen the jam nut at the cable adjuster located behind the operating pedal and adjust the cable by means of the cable adjuster.

2. Remove the cable from the clutch release fork gaiter and the clutch housing.

3. Disconnect the lower end of the cable from the clutch release fork, underneath the housing, withdrawing it through the large hole in the housing in the fork.

4. Remove the clutch release fork gaiter from the clutch cable and withdraw the cable from the adjustment hole in the clutch housing.



Removing the Clutch Cable

5. Remove the retaining pin from its nylon seat situated at the top of the clutch pedal and withdraw it from the cable eyelet.

6. Withdraw the cable from the pedal support bracket and remove the cable from the vehicle, complete with the bulkhead grommet.

To Install

7. Pass the lower end of the cable through the bulkhead and fit the rubber grommet to the bulkhead.

8. Feed the upper end of the cable up through the pedal support bracket and through the nylon seat in the pedal. Slide the retaining pin through the hole in the cable eyelet and press the pin and eyelet firmly into the groove in the nylon seating.

9. Pass the lower end of the cable through the hole in the engine backplate and fit the release fork gaiter over the clutch cable.

10. Lightly grease the cable nipple. Connect the lower end of the cable to the small hole of the keyhole in the release fork and replace the release fork gaiter in the clutch housing.

11. Adjust the clutch pedal free travel as described in operation 16-713.

16-815 BEARING - CLUTCH RELEASE - REMOVE AND INSTALL

To Remove

1. Remove the transmission as described in operation 16-114. On vehicles with ZF transmissions, remove the clutch housing from the transmission.

2. Remove the clutch release fork and clutch release bearing and hub assembly from the clutch housing by withdrawing it from its pivot and through the opening at the side of the clutch housing.

3. Remove the clutch release bearing retaining device (circlip or spring lugs).

4. Remove the release bearing and hub assembly from the release fork.

NOTE: The bearing is supplied as an assembly and should not be dismantled further.

To Install

5. Assemble the clutch release bearing and hub assembly to the clutch release fork by aligning the mating tongues and grooves.

6. Secure the bearing with the circlip or spring lugs. Lightly grease the fork end.

7. Assemble the clutch release fork and hub assembly to the clutch housing by passing it through the clutch housing side hole and locating its small fork end at the pivot.

8. On ZF transmissions install the clutch housing on the transmission. Replace the transmission as described in operation 16-114.

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- 12 121 BRAKES - INSPECT** (includes: remove and install wheels and brake drums, remove dust, check moving parts. For operation, system for leaks, shoes for wear, adjust foot and handbrake where applicable)

A-Series - Apr 1979

1. Raise the front and rear of the vehicle and fit axle stands.
2. Remove all wheels and brake drums as detailed in operations 12 311 and 12 313.
3. Remove dust, with a pressure air line, from the brake assemblies and brake drums.
4. Check all moving parts for operation, i.e. rear automatic adjusting mechanisms, retracting springs and wheel cylinder pistons.
5. Check the front brake adjusters. 254 mm (10 in.) brakes; check the serrations on the adjuster plate and correct engaging of the pawl. 317 mm (12 in.) brakes; ensure the adjuster peg is secure within the mechanism and the peg and shoe web slots are liberally lubricated with molybdenum disulphide grease.
6. Check the position and condition of all brake hoses, pipes and connections.
7. Check the wheel cylinders and hoses for leaks.
8. Check brake shoes for wear and drums for scoring and grooves.
9. Check for free movement of the parking brake cables, parking brake rods and parking brake levers, adjust as necessary.
10. Check brake master cylinder and/or booster for tightness and correct function.
11. Check and if necessary adjust push rod to master cylinder piston clearances as detailed in operation 12 335.

NOTE: Avoid inhaling brake shoe dust during brake shoe repair or inspection.

12 141 BRAKE SYSTEM - BLEED - SINGLE LINE UNBOOSTED

1. Remove the reservoir cap and top up with approved brake fluid.
2. Remove the rubber dust cap from the left hand rear bleed nipple and fit a bleed tube.
3. Place the other end of the tube in a glass jar containing a sufficient amount of approved brake fluid to keep the end of the pipe immersed during the bleeding operation.
4. Unscrew the bleed valve approximately half a turn. Fully depress the brake pedal and release to the off position. Brake fluid and/or air should have been pumped into the jar, if not, unscrew the bleed valve further.
5. Continue to depress the brake pedal, pausing after each return stroke, until the fluid seen to enter the jar is clean and free from air bubbles.
6. Depress the brake pedal fully and maintain in this position whilst the bleed valve is tightened. **NOTE:** Do not over tighten the bleed valve.
7. The master cylinder reservoir must be topped up with approved brake fluid during the bleeding operation.

OP 2018-B FRONT BRAKE SHOES - REPLACE

It is important that brake shoes are changed in sets, i.e. do not change the shoes on one side of any axle assembly.

Tool: Adjusting Nut Wrench Adaptor - C 1032

To Remove

1. Remove the wheel trim and the grease cap and back off the brake adjuster.
2. Jack up the vehicle, fit chassis stands and support the wheel with a wheel trolley.
- 3(a) 4,300 kg. (9,500 lb. axle). Remove the split pin, unscrew the bearing adjusting nut and withdraw the thrust washer and the outer cone and roller assembly.
- 3(b) 4,990 kg. (11,000 lb. axle). Bend back the tab washer and unscrew the locknut. Remove the tab washer and lock ring, unscrew the adjusting nut using Tool number C 1032 and remove the outer cone and roller assembly.
4. Remove the wheel, hub and drum assembly using the wheel trolley and drive out the inner cone and rollers and the hub seal but do not damage the roller cage.
5. Carefully lever the trailing edge of each shoe away from its abutment slot in the wheel cylinders. Gradually release one shoe so that the retracting springs can be detached and the brake shoes removed.
6. Blow out any dust present in the drum and back plate taking care not to inhale any of the brake dust. Goggles must be worn to protect the eyes and all the normal precautions must be taken when using compressed air in this manner.

To Replace

1. Fit the retracting springs to the brake shoes and slide the leading edge of each shoe into the locating slot in its wheel cylinder piston. Carefully lever the trailing edge of each shoe into its abutment at the rear of the wheel cylinder.

Fig. 26 Dual Air Actuator Mounting
(1) ACTUATOR
(2) INDICATOR ROD
(3) WARNING LIGHT SWITCH
(4) MASTER CYLINDER

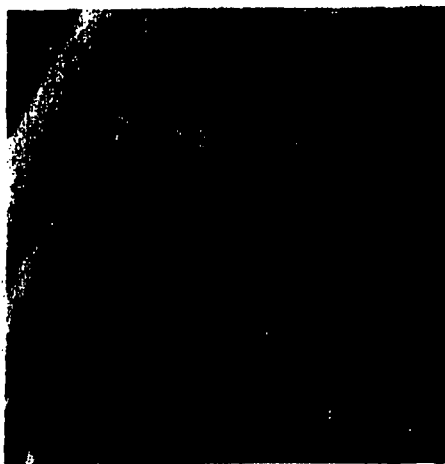


Fig. 27 Front Brake Assembly
(1) WHEEL CYLINDERS
(2) RETURN SPRINGS



Section 2 — 34

PRE '82 R-SERIES

JUNE 1970

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12 141

BRAKING SYSTEM

- 6 Continue depressing the brake pedal, until no more air bubbles emerge from the tube

NOTE: It is important that the fluid level in the reservoirs is maintained during the brake bleeding operation. NEVER replenish the reservoirs with fluid drained from the system as it may be contaminated or aerated. If the fluid in the system is dirty it is advisable to drain it completely and refill with fresh fluid.

- 6 When, with each depression of the brake pedal, fluid alone comes out of the bleed tube, hold the footbrake pedal in the fully depressed position and tighten the bleed valve

CAUTION: Do not use excessive force when tightening the valve.

- 7 Remove the tube and refit the rubber cap on the bleed valve

- 8 Repeat these operations on the other wheels, starting with the wheel having the next shortest pipeline run. Bleed at the wheel having the longest pipe line run last

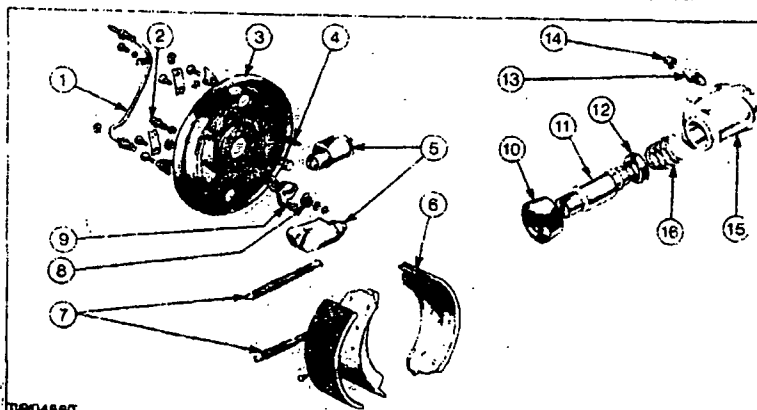
- 9 Top up the reservoirs to the correct level and replace the caps.

12 283 SHOES - FRONT BRAKES - REMOVE AND INSTALL (One Side) (Includes: Adjust both Sides)

⚠ WARNING: Brake lining dust is injurious to health if inhaled and proper care must be taken when cleaning the brake drums and/or back plates.

To Remove

- 1 Ensure that the park brake is applied.
- 2 Position a jack under the centre of the front axle and raise the vehicle sufficiently to fit stands under each end of the axle.
- 3 Using a wheel trolley, remove the wheel and brake drum assembly as one unit, as detailed in Operation 14 371
- 4 Using the Brake Shoe Horn (Tool No 64947016), prise one of the shoes from its abutment slot on the wheel cylinder
- 5 Gradually release the tension on the shoe to enable the other shoe to be removed from its abutment slot on the other wheel cylinder



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Hydraulic Two Leading Shoe (HLS/S) Front Brake Assembly

- | | | |
|-------------------|----------------------|-------------------------|
| 1 Bridge pipe | 7 Shoe return spring | 13 Bleed valve |
| 2 Brake adjuster | 8 Shoe cam | 14 Dust cap |
| 3 Back plate | 9 Shoe adjuster | 15 Wheel cylinder body |
| 4 Steady post | 10 Dust cover | 16 Piston return spring |
| 5 Wheel cylinders | 11 Piston | |
| 6 Brake shoe | 12 Piston seal | |

BRAKING SYSTEM

12 285

- 6 Remove both shoes complete with the retracting springs

- 7 Note the positions of the retracting springs and remove the springs from the shoes.

- 8 Wire the wheel cylinder pistons to keep them retracted.

To Install

NOTE: Ensure that the brake shoe lining material of the replacement shoes is of the correct specification. Check the letter code on the side of the brake shoe lining (see Specifications)

- 9 Refit the brake shoe retracting springs in the positions noted during removal

- 10 Locate the shoe web of each brake shoe sliding edge into the slot at the end of the wheel cylinder piston

- 11 Using the Brake Shoe Horn (Tool No 64947016), lever the shoe web of each brake shoe trailing edge into its abutment slot at the rear end of the wheel cylinder. Remove the retaining wire from the cylinder pistons

- 12 Taking care not to damage the brake linings, refit the wheel and brake drum assembly as detailed in Operation 14 371

- 13 Remove the two rubber plugs at the rear of the brake dust cover which cover the brake shoe steady posts, slacken the steady post locknuts and unscrew both steady posts two full turns using Adjuster Tool No 64927025

- 14 Turn the brake adjusters in a clockwise direction until the shoes are in firm contact with the drum

- 15 Using the Adjuster Tool No 64927025, screw in one steady post until it just contacts the brake shoe web, then tighten the locknut. Refit the steady post rubber plug

- 16 Repeat the operation on the other shoe steady post.

- 17 Adjust the brakes as detailed in Operation 12 132.

- 18 Remove the stands and lower the vehicle to the ground.

12 285 SHOES - REAR BRAKES - REMOVE AND INSTALL (One Side) (Includes: Remove and Install Wheel and Adjust Both Sides).

⚠ WARNING: Brake lining dust is injurious to health if inhaled and proper care must be taken when cleaning the brake drums and/or back plates.

To Remove (H2 L/S)

- 1 Check the front wheels.

- 2 Slacken the wheel nuts.

- 3 Position a jack under the centre of the rear axle and raise the vehicle sufficiently to fit stands under each of the axle.

- 4 Release the park brake.

- 5 Remove the wheel nuts and, using a wheel trolley, remove the wheel

- 6 Remove the hub and brake drum assembly as detailed in Operation 15 374.

- 7 Slacken the brake shoe adjusters.

- 8 Using the special Tool No. 64927026 or a suitable hook tool, unhook and remove the brake shoe retracting springs.

- 9 Wire around the expander tappets to retain the rollers and wedge in position.

- 10 Using the Brake Shoe Horn (Tool No 64947016), prise the shoes from their abutment slots in the wheel cylinders and remove the shoes complete with shoe carriers from the brake carrier plate

- 11 Wire the wheel cylinder pistons to keep them retracted.

- 12 Disconnect and remove the carrier return springs.

- 13 Remove the brake shoe carriers from the brake shoes.

To Install

NOTE: Ensure that the brake shoe lining material of the replacement shoes is of the correct specification. Check the letter code on the side of the brake shoe lining (see Specifications).

R-SERIES - 1978 onwards

12 285

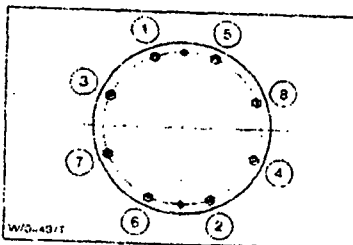
16 724 4 MANUAL TRANSMISSION AND CLUTCH

9 Place the clutch disc in position on the flywheel with the shortest spigot of the splined hub towards the flywheel, using clutch disc alignment tool (No C7088).

10 Place the pressure plate in position ensuring that the dowels in the flywheel are aligned with the dowel holes in the clutch pressure plate cover.

11 Fit the retaining bolts together with new lockwashers and screw them in until they are all just lightly clamping the pressure plate.

12 Screw in each bolt one turn at a time in the sequence shown (see illustration) to carefully and evenly pull the pressure plate up to the flywheel and load the pressure plate springs. Ensure that the dowels engage correctly with the dowel holes. Finally tighten the bolts in a clockwise sequence to the specified torque (see Specifications).



Clutch Cover to Flywheel Bolt Tightening Sequence.

13 Remove the disc alignment tool.

16 784 4 CLUTCH HOUSING - REMOVE AND INSTALL (Transmission Removed)

To Remove

1 Unscrew and remove the two bolts securing each trunnion in the slave cylinder mounting bracket on the clutch housing. Withdraw the two trunnions and remove the slave cylinder and the two side packing washers from the clutch housing. Swing the slave cylinder aside and support it to prevent damage to the hydraulic fluid and air lines.

2 Place a suitable jack under the rear portion of the sump and support the engine.

3 Slide the clutch release bearing and hub assembly off the fingers of the release arm fork and withdraw the bearing and hub assembly via the transmission main drive shaft aperture in the clutch housing.

4 Remove the self-locking nut and the centre bolt from the engine right-hand rear mounting.

5 Remove the four bolts securing the engine right-hand rear mounting bracket to the clutch housing and withdraw the bracket.

6 Remove the four bolts securing the engine left-hand rear mounting bracket to the clutch housing.

7 Remove the fifteen bolts securing the clutch housing to the engine. Move aside any cables or pipes that were connected to the housing. Pull the housing off the engine and remove the housing from the vehicle.

8 Remove all the asbestos dust lining from the clutch housing.

WARNING: Asbestos dust is injurious to health and must not be inhaled. Do not blow the dust off with an air line. Use a suitable vacuum cleaner. If a vacuum cleaner is not available, use personal protective breathing equipment or a suitable face mask and remove the dust carefully with a brush or rag. Collect the dust in a sealable plastic bag or envelope for disposal.

9 Remove the clutch release arm rubber gaiter from the clutch housing aperture and pull it off the release arm.

10 Pull the clutch release arm to disengage it from the trunnion pivot ball and remove the arm from the housing.

11 Remove the release arm pivot trunnion ball from the clutch housing.

12 Thoroughly clean all component parts. Discard the old rubber gaiter, self locking nuts and all lockwashers.

13 Inspect all parts for excessive wear or damage. Renew all serviceable parts.

To Install

14 Screw the release arm pivot trunnion ball into its location inside the clutch housing together with a new lockwasher and tighten to the specified torque (see Specifications).

MANUAL TRANSMISSION AND CLUTCH 16 784 4

15 Place a smear of grease on both the pivot ball and in the ball socket in the release arm. Lift the retaining spring clip with a screwdriver and slide the arm over the ball until the ball is entered securely in the socket. Release the retaining spring clip.

16 Pull a new release arm rubber gaiter over the arm and position the gaiter groove on the rim of the clutch housing aperture.

17 Pack the internal recess of the clutch release bearing hub with high melting point grease (see Specifications) and pass it over the transmission main drive gear bearing retainer tube to scrape off surplus grease. Place a light smear of high melting point grease on the clutch release arm fork thrust pads and on the release bearing hub thrust pads. Remove all surplus grease from the exterior of the release bearing and hub assembly.

CAUTION: Any excess grease on the release bearing may be thrown off by the rotation of the bearing and contaminate the clutch disc friction linings.

18 Place the clutch housing into position. Align the two dowels in the clutch housing with the corresponding holes in the flywheel housing and push the housing home.

Screw in the fifteen retaining bolts, together with new lockwashers, ensuring that the clips supporting any cables or pipes are placed over the appropriate bolts. Tighten the bolts to the specified torque (see Specifications).

19 Align the bolt holes and screw in the four bolts securing the engine left-hand rear mounting bracket to the clutch housing together with new lockwashers and tighten to the specified torque (see Specifications).

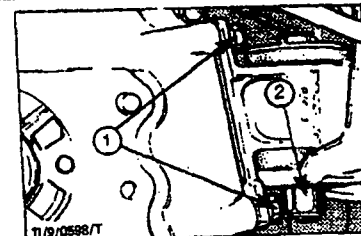
20 Place the engine right-hand rear mounting bracket in position.

Enter the centre bolt and screw on the self locking nut three or four threads.

21 Align the bolt holes, screw in the four bolts securing the bracket to the clutch housing together with new lockwashers and tighten to the specified torque (see Specifications). Tighten the centre bolt and nut to the specified torque (see Specifications).

22 Remove the jack from beneath the engine.

23 Replace the clutch release bearing and hub assembly on the release arm fork via the transmission main drive shaft aperture.

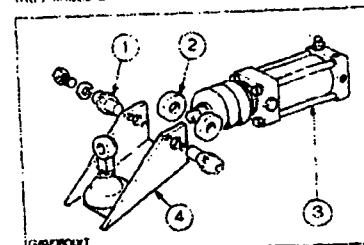


Engine Rear Mounting Bracket

1. Rear mounting bracket
2. Rear mounting plate nut

24 Lightly grease the trunnion bushes in the slave cylinder, the push rod end where it bears on the release arm and the two side spacer washers.

25 Place the slave cylinder in position on the clutch housing ensuring that the push rod has engaged correctly with the recess in the end of the release arm.



Air Assisted Slave Cylinder Mounting Assembly

1. Trunnion
2. Packing washer
3. Air assisted slave cylinder
4. Clutch housing bracket

26 Place the two side spacer washers in position between the air cylinder and the trunnion mounting brackets.

27 Align the holes in the trunnion mounting brackets, the spacer washers and the trunnion recess bushes in the air cylinder and insert the trunnions. Screw in the four trunnion retaining bolts with new lockwashers and tighten to the specified torque (see Specifications).