

Motor

**THE VOLVO WAY:
SPECIAL SUPPLEMENT**

**Mercedes 230 4 tested
Gas turbines: just round the corner?
Carreras for the champs
In gear for winter**



**The Hunter
they all chased:
track test**

THE VOLVO WAY

What makes Volvo different? Scandinavian culture, Sweden's high standard of living, her cold climate, social and environmental awareness? These and other factors have helped to shape a company that's respected through the world, not least in Britain where Volvo sales are expected to top 24,000 this year. To compile this special supplement, George Bishop and Mike McCarthy went to the Volvo works at Gothenburg to talk to key men about revolutionary production methods, engineering philosophy, new developments, safety (Volvo's ESV prototype is shown below), durability . . . about the Volvo way



'The best way to beat a competitor is to improve yourself'



Volvo's president,
Pehr Gyllenhammar.

More

Whither Volvo? What makes it tick? Why has the company been stopped by strikers for only one day in 25 years. To find these kind of answers we planned an interview with Pehr Gustaf Gyllenhammar, President of Volvo at 38, who speaks English, French and German just as well as his own Swedish, and is a nice guy to boot.

He has been president for two-and-a-half years, before that married the daughter of the former president and was himself president of an insurance company and a bank. He was to fit us in during his two hours at home between a trip to the United States—where Volvo are building a 100 million dollar factory—and the next overseas voyage.

But airlines and weather can foul up even presidents, and we didn't make the interview. Instead Volvo switched on a recording of a television interview, produced some of their top brass, and opened all doors except that to their proving ground, where something secret is going on and all visitors are banned.

The company has hit the recent headlines most of all for its attempt to plough some interest back into the soul-destroying job of making motorcars on a production line by doing away with the line itself and by other means. There are for instance two trade union representatives who are full members of the Board of Directors, and workers have a big say in what goes on.

Pehr Gyllenhammar states that their philosophy is that a car should be long lasting, safe and economical. "We are not in favour of cosmetics". Safety, he says, is part of the austere Swedish culture. "We also make solid things". Five years ago they had problems relating to the workforce—high turnover and absenteeism—and decided that people did not work as well as they used to and the company should do something about it. That is where the new deal came in.

They tried to make the work less monotonous, to automate dirty jobs, to reduce noise in the factory. Since then the turnover of labour has improved but absenteeism has got worse because in Sweden it doesn't cost you a penny to be off work owing to the social security blanket. But, says Mr Gyllenhammar: "it is a Utopian concept to expect people to want to work.

It is a good thing people can afford to be ill. Some years ago they couldn't. The objective should be that the system serves the man."

Questioned about the no-track assembly system he says it is no slower, because the slowest system is when people stay away. "We must get enthusiasm back" he says. "It is vital to have the unions involved. Quality and performance must be there every day in a motorcar. The best way to beat a competitor is to improve yourself".

Since the New Deal at Volvo, Sweden has suffered something of a recession, which has helped with their labour problems, but the philosophy expressed by their president makes it crystal clear why the company can produce quality cars which can perform in all climates, are reliable, and saleable all over the world. A man who uses one to drive hard and fast on business on Europe's motorways told us: "I will forgive my Volvo everything because it always gets there".

The company and its premises are an eye-opener to visit. At the main Torslender plant there is a sports centre for employees and their children, with a swimming pool, tennis bowling, gymnasium, all to the highest standards. The buildings are attractive and well-designed, the setting pleas-

ant. A Volvo car takes 18 hours to build, 10 of them spent on painting.

There are many women on the assembly line—still in use at Torslender—and they are paid the same rate as men. In the garage-type pit where line rejects are put right the underground pit is fully equipped with tools and spare-part bins so that the men can stay there and get right job instead of popping in and out for spanners, spares and so on.

Alongside the assembly track are comfortable seats where workers can be seen reading a book or taking a coffee break whenever they feel like it, or just waiting for the next car to come along. There is no pressure or chasing; that's not the Volvo Way. Eventually axles, correctly spaced a wheelbase apart, meet the body shell at the Marriage Point and drop together. Special jigs enable the bodysell to be turned on its side so that men and women can work standing up instead of crouching underneath.

All these things are not done simply because Volvo love their workers more than any other company. They are good for business and might be described as enlightened self-interest. But judging by the results—production up, profits up, demand always unsatisfied—some their ideas may be worth copying elsewhere.

GB



Volvo, you may have noticed, always come out top in the Swedish government tests on old cars, with a life expectancy of 14 years or something of the sort, while some British makes do very badly indeed. I was told to find out Why? The simple answer of course is that there's a lot of snow up there towards the Arctic, and a lot of salt on the roads. So there's a lot of body rot, but cars built in Sweden are built with this knowledge in mind, as the snow goes on for more than half the year in northern parts.

The testing is the equivalent of our MoT, and starts when a car is two years' old. It is called AB Svenks Bilprovning, Bil being the Swedish word for car and the "provning" self-explanatory. We went along to the nearest testing station in Göteborg (there's one in every large centre of population) to see how it's done.

The car owner is sent a postcard by the test people, and must then present his vehicle at the centre. The test covers 31 items and takes about 25 minutes including a one-kilometre test drive. If the car fails, the owner must have it repaired and come back within a month. If it fails again he has another 14 days to put it right. If there is a serious fault he may not drive the car away.

Tests cover: electrical system, footbrake, handbrake, steering, springs, wheels and bearings, front suspension, brake linings, shocks, exhaust system, chassis, transmission, rear axle, wheels and tyres (different from other test), fuel tank and lines, mud flaps, towing hitch, head lamps, coachwork, boot, reflectors, driver's seat, rearview mirror, number plate lamp, wipers, stoplamp, wipers, horn, controls, speedometer, emission.

The emission test is watered-down for older cars. We were intrigued to see the tester block up one of the dual exhaust pipes of all VWs and test the other. We picked on music student John Olaf Larsson and his '64 Volvo 544 which had covered 240,000 kilometres, 130,000 miles before he bought it in '69.

His car was showing obvious signs of rust, and the tester was busy bashing holes in the subframe with his pointed hammer while waiting for our photographer to shoot, but John was granted his '74 red sticker. The colour changes every year so that a policeman can spot an untested car on sight. The driver must also carry his copy of the pass certificate. John had actually passed the main body of the test before and had come back for a recheck on some minor failure.

The testers use a rolling road dynamometer, an exhaust analyser, a beam setter, and a device which shows up wheel alignment on a dial. It is all thorough, professional, and friendly.

salt, less rot

Sweden is cold and they use lots of salt on the roads.

Volvo allow for it, as the "Bilprovning" tests and our own owner survey confirm



Above: Volvo 544 with 130,000 miles on the clock, undergoing its compulsory Bilprovning test in Sweden

Left: the red windscreen sticker indicates that the 544 has passed its test. The driver must also carry a pass certificate

YOU AND YOUR CAR—24 VOLVO 144

The important point to remember in this survey, particularly when making comparisons, is the high mileage and length of ownership—over twice as far and long. This should make the results that much more meaningful and representative. Thus the days off the road averaged 2.6—the same as the Granada—but over a much higher mileage. In fact if the days off the road for those owners who have done less than 21,000 miles is considered this figure drops to 1.6.

The tone of the survey in general bears out the reputation that Volvo have for reliability, and there is a high degree of satisfaction at both the agents repair work and availability of spares. Looking at the likes and dislikes, comfort and reliability rank high (so does boot space) although noise seemed to come in for some criticism.

Thus the Volvo emerges as a solid, reliable, comfortable (if slightly stodgy) car, with a higher than average proportion of owners who like such characteristics, and who would buy another.

1 Who bought it?

Sample size	Volvo	Granada	2.5PI
Driver's age	66	41	89
25 and under	3	5	7
26-35	23	19	27
36-45	19	25	21
46-55	32	32	26
56-65	14	17	26
66 and over	5	2	3
No answer	4	—	—
Average age (years)	45	44	42

2 Background information

Car's age	Volvo	Granada	2.5PI
6 months or less	—	88	22
12 months or less	25	12	47
13 months to 2 years	28	—	31*
Over 2 to 3 years	20	—	—
Over 3 years	27	—	—
Average age (months)	25	4	12
*over 12 months			
	Volvo Since new*	Granada Since owned*	2.5PI
10,000 or less	20	22	83
11-20,000	21	37	17
21-40,000	21	24	—
41,000 and over	38	17	—
Average mileage	30,000	23,000	6500 14000
Bought new or used			
New	73	100	93
Used	27	—	7

Ownership	%	59	66
Private	83	—	—
Company	17	46	34
Gearchange			
Manual	67	17	85
Automatic	29	83	12
(Overdrive)	(14)	—	—
No answer	4	—	—

*This breakdown was needed as so many owners had bought their car secondhand.

3 Likes and dislikes

Owners were asked to rate the items shown below. As before, excellent got 10 out of 10, good 7, average 4, poor 2 and bad nil.

Sample sized based on	Volvo	Granada	2.5PI
Scores out of 10	66	41	89
Acceleration	6.3	8.3	9.2
Cruising	7.6	9.0	9.0
Steering	6.2	8.3	6.2
Roadholding	6.2	7.8	7.0
Braking	8.5	7.0	7.8
Gear ratios*	6.8	6.7	7.4
Gear change*	6.5	—	5.8
Ride comfort	7.1	8.8	7.0
Seat comfort	9.0	8.6	7.5
Heating	8.3	5.6	6.5
Ventilation	5.3	3.6	6.8
Noise	4.8	7.8	6.3
Instruments	5.6	6.9	7.3
Minor controls	6.5	6.4	7.5
Fuel consumption	6.3	5.0	5.9
Wear on tyres	8.1	6.4	4.9
Visibility	8.3	6.6	7.5
Lights	6.5	4.3	6.7
Boot space	9.8	8.8	6.5
Reliability	9.1	6.9	6.1
Styling	6.1	8.0	7.1

*Excluding those with automatic transmission.

4 What went wrong

Sample size—faults	Volvo	Granada	2.5PI
To do with	249	189	636
Engine	28	12	20
Transmission	11	12	15
Steering, suspension	6	3	11
Brakes	10	11	5
Electrical	14	20	18
Body, paint, chrome	17	24	15
Fittings, trim	9	14	10
Instruments	5	4	6
Average per car	3.8	4.6	7.1

Engine: The most common fault was to do with the exhaust/silencer (38%). While most of this was probably due to fair wear and tear, some owners complained specifically of faulty baffles or brackets. 12% had leaking radiators or water pumps; 10% oil leaks—usually it seemed, from the front end of the crankshaft; and 10% had miscellaneous carburettor faults.

Transmission: 11% had gearbox oil leaks and 6% oil leaks or problems with the rear axle. 9% had problems at the clutch—about half of these were to do with the clutch cable.

Steering, suspension: There was no common fault here—though 8% had replaced a shock absorber or two.

Brakes: 21% had replaced their brake pads—some of them appeared to be the fault of the brakes rather than wear and tear. 12% had hand brake problems.

Electrical: The usual variety of faults here—those maintained by 4 or more owners were washer motor, bulbs and indicators.

Body, paint, chrome: 26% complained that the paint chips easily, is thin, rust around sills, wheel arches, etc.; 6% thought that chrome on the bumper/lights was poor/rusty; and 6% had problems to do with the quarterlights.

Fittings, trim: The only two problems mentioned by 4 or more owners were the windscreen trim becoming loose (9%) and door handle or window falling off (6%).

Instruments: No particular problems mentioned with any

frequency here.

5 Time off the road

Sample sizes	Volvo	Granada	2.5PI
Nil days	66	41	89
1/1 day	48	41	19
2-4 days	12	17	11
5-8 days	23	25	31
9-14 days	5	7	7
15-31 days	9	5	10
32 or more	2	3	13
Average No of days	2.6	2.6	6.2

Comment: 32 or more days have been excluded when calculating the averages on the ground of being possibly unlucky flukes which samples of these sizes could not hope to measure with any great reliability.

6 Servicing

How it was serviced*	Volvo	Granada	2.5PI
Self/unpaid friends	27	7	17
Local garage	12	7	14
Manufacturer's agent	80	95	83
If agent, is work			
Good	62	44	43
Fair	15	41	39
Bad	3	10	18

* Adds to more than 100 as some owners used more than one place for normal servicing.

Warranty claims	%	%	%
No faults put right under warranty	56	17	9
At least one fault put right	44	83	91
Sample—those with experience	37	34	81
Satisfied	73	62	63
Not wholly/at all satisfied	27	38	36
If not, why not?			
Still faulty	8	15	19
OK for 1, not others	8	—	5
Caused another fault	5	—	—
Other answers	11	30	15

7 Spares

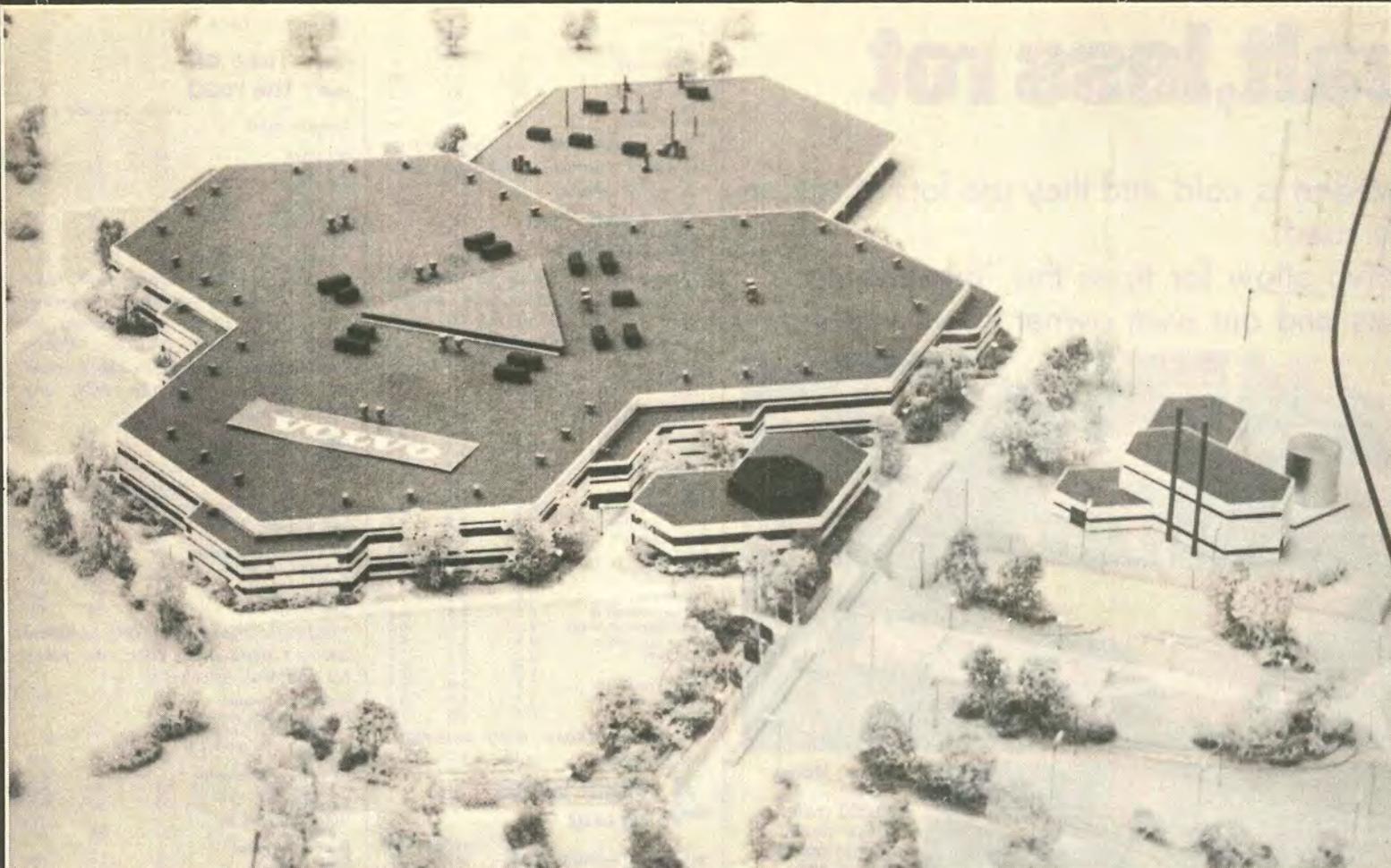
Availability of parts	Volvo	Granada	2.5PI
Good	70	32	28
Fair	18	27	31
Bad	3	29	29
Don't know yet	9	12	12
Trouble getting parts			
No parts been difficult	70	46	30
At least one part has been difficult	30	54	70

8 Would you buy another?

	Volvo	Granada	2.5PI
Yes	73	56	52
No	27	44	48
If not/not sure, why not?			
Interested in others	6	5	9
Price	6	—	5
Want other Volvo model	5	—	3
Problems	5	12	16
Heavy steering	3	—	2
Poor/dated performance	3	—	—
Noisy	3	—	—
Other answers (mentioned by no more than 1 owner)	15	19	—



Bishop was there to see fair play. Rolling road and exhaust analysis are part of Bilprovning tests



THE NEW DEAL

Contented workers, no matter what their nationality, are apt to make better cars, as George Bishop found out

Do Volvo's modern methods make the cars better and the workers happier? This was the double question put to Mr Sten-Ake Ewergardh, Vice-President and General Manager of Industrial Engineering Coordination. He is a very large, serious and young man who was formerly in charge of production at Torslander, the main plant, and also of the press shop and body shop, so knows most of the answers before you have framed the questions.

The question of the state of morale and turnover of workers depends largely, he said, upon whether you have a hot climate or a cold climate economically speaking, or in plain language how many unemployed there are. In Goteborg (Gothenberg) there are relatively many unemployed.

"Production engineering objective is to model production plans in such a way that they offer an efficient coexistence between men, material and equipment in order to achieve better quality and increase productivity and work satisfaction."

We talked for two hours so this can be only a brief summary, but

the first step before introducing the new working methods was a technical job evaluation. The New Deal came in 1971. Volvo deal with only one trade union, which is a help. Before that, in 1968 and 1969, labour turnover was such that to achieve a net increase of 1000 workers meant hiring 4000—Finns, Yugoslavs, and others which brought language problems too.

I told Mr Ewergardh the story of a man who visited the factory and was told: "See that man over there? We call him 'The Swede' because he's the only one." He smiled wanly. "Possibly so," he said. "Now we have 58 per cent Swedish and 42 per cent foreign, of whom 25 per cent are Finnish who tend to be young and unmarried and turn over fast."

When there was a big production increase the company hired many recruits, but there was big turnover and absenteeism. There was discussion with the unions, who did not believe the reasons the company gave for people leaving, or the company figures. So union men were trained to do the finding out. They reported that 50 per cent left because of factors



Top: no production line at Kalmar, but individual assembly units in the points of the star-shaped building. Above: avoiding boredom—workers meet to decide who does what under the job-switching plan

inside the factory, transport problems and so on, long journeys to work. Men left and then women followed their husbands to their new workplace.

Matters became worse when the school-leaving age was raised. Volvo trained 4000 people in one year and lost many. In all 20,000 non-Swedes were coming into the country each year to fill job vacancies nationwide. Then the company decided to improve the factory environment, first by the "Four Ells." This covered Noise (Ljus in Swedish), Light (Ljud), Air (Luft), and Layout (same word borrowed). Then came the six Ks: Cost, Quality, Quantity, Communication, Feeling, and Knowledge and don't ask for translations.

Even before this there had been agreements which would startle

many a British negotiator. In 1966 a new agreement had been reached on workers' councils which took two-three years to implement. The basis was Consultation before Decision. There was agreement too on the American MTM (Method Time Measurement) scheme under which operations are filmed and the union agreed to no disputes on time. They accepted an agreed speed of 111 per cent of MTM.

Then came job evaluation, which covered points for such things as bad environment, speed of operation, and resulted in seven pay classes. But there is only one man in class 1, who is a trouble-shooter in the press shop and only 16 in class seven. Most fall in classes 3, 4 or 5. A committee of three labour, three management, fix evaluations. The chairman, a

company man, has no casting vote.

But in 1966 the Volvo 142 (14 means Passenger Car) code name P1400 was easy to assemble. Now it is much more complex with the safety factors, emission control and so on. Thus you cannot compare productivity. This was the first answer to my question as to whether productivity had gone up as a result of the good-neighbour policy.

Air conditioning for the United States is another complication on Volvo cars today. Annual turnover of workers at Torlanda is now 28 per cent, which is average. "But this may be due to the economic climate. The effect of the environmental changes is really unknown." The unions—who, now remember, do the reporting—say the trend is to reduced turnover.

Internal communications, always a problem, have improved. They now have a works' newspaper in Finnish, Serbo-Croat and funny enough Swedish. There are even

(very) local editions for each shop. Sweden has a workforce of about 4 million of whom 300,000 live in Goteborg and 100,000 are unemployed today. Mr Ewergardh thought morale had improved, but he didn't know. Certainly it is now easier to recruit Swedes perhaps because the Volvo image has improved. They have lost one day in 25 years to strikes, although 400,000 of Sweden's 4 million workers are absent from their jobs daily.

Goteborg has 300,000 workers, as we have seen, out of its 500,000 people and Volvo, the biggest employer next to the municipality, employ 16,000, half the number of civil functionaries. My production chief could not quote me any warranty claim figures as this is not his department, but I thought this might give a clue to whether quality had improved or not.

What he did tell me was that Volvo have a register of every owner (presumably only in

Sweden) and can tell from their computer exactly what model he is driving. Thus it is easy to deal with recalls, in the unlikely event that they had any. They carry only four hours' stock of many components, and the engine made 150 kilometres away today is in the car here (Torlanda) tomorrow.

"The unions appreciate this factor and we are all trained to it. There must be no stoppage in the chain."

Dual sourcing of components is sought in all cases. Some years ago Volvo became discontented with the constant failure of supplies from England, but they now try to dual-source everything on the basis of say one supplier in France and another in Germany.

Decisions made by the workers through their union are big ones. For instance they were asked how the company should spend 50 million kroner (about £5 million) in the Torlanda works.

Just what has been done for the workers? Well, although most Volvo factories have been built since 1960 they have spent 175 million kroner (£17.5 million) in working environment improvements and better production methods in the past four years. The workers were asked what colours they would like their factory painted, and their wishes were complied with. Screens were put up to silence the noise of the stamping presses, and certainly it is the quietest press shop I have been in. You can even talk in there.

Lighting has been improved, air conditioning installed, job alternation, under which people do a different task every few hours, has been brought in. In the Torlanda plant 1400 people are now involved in new forms of job layout and the plant and machinery have been adapted to suit the new ideas.

Thinking is to eliminate monotonous work and give work-people more responsibility, thus more interest in their jobs. Some people switch jobs once a day,

but those on internal sealing of car bodies on Line IV A work in cramped conditions so they switch every other hour. There are 17 different operations on this line. In another case on body assembly one group follow the body for seven or eight stations along the line for 20 minutes. They are also responsible for control and adjustment right up to final inspection.

A group may appoint its own team boss who keeps contact between the group and production leadership and hands out jobs between members. Meetings are held to discuss problems and make suggestions for improvements in tools, schedules, etc. Of the 10,336 line workers at Torlanda 1642 are women, and they sling a hammer or a welding torch with the best of them.

On Line II at Torlanda there were only 24 men engaged in job switching in 1970, whereas today there are well over 300. A behaviour pattern specialist measures the effects of the changes (no, I don't know how) and reports back. The conclusion: "As yet it is too early to evaluate the results of the new forms of working layout. There has been a decrease in personnel turnover and absentee figures. There are also indications of higher quality and less subsequent adjustment work."

The big crunch will of course come at Kalmar, the new plant over on the East Coast of Sweden which will open next year. There the moving track will be dispensed with altogether and workers in groups assemble cars at stations in a star-shaped factory. This is of course going back to the way Bentleys did it in the 1920s, with a small group being responsible for each creation. Something similar was also done in the Sunbeam/Talbot/Darracq factory in Barby Road until Rootes (now Chrysler) took over in the 1930s.

Now the wheel has turned full circle and Pehr Vyllenhammer has decreed: "A way must be found to create a workplace which meets the needs of the modern working man for a sense of purpose and satisfaction in his daily work. A way must be found of attaining this goal without an adverse effect on productivity."

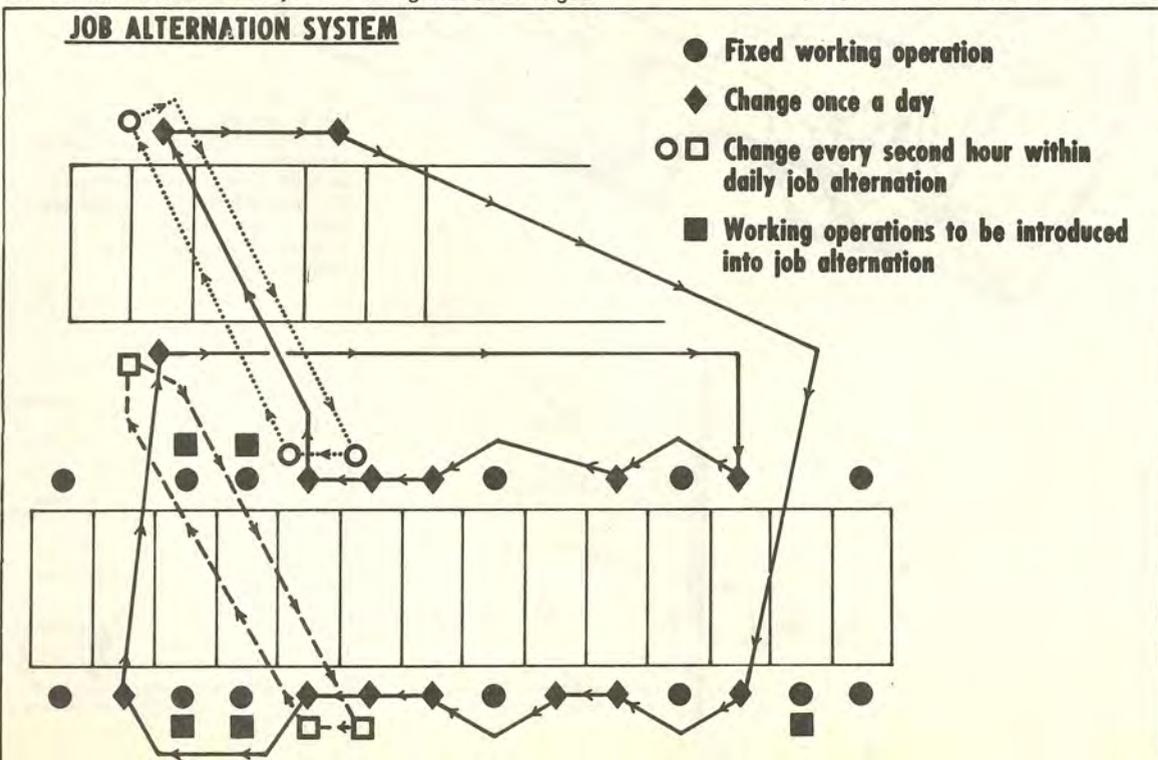
This is easier at Kalmar, which will make only 30,000 cars per shift a year as compared with Torlanda's 180,000. But at Kalmar teams of 15-25 workers will agree between themselves on distribution of work and when they should switch jobs. Bodies will move between teams on self-propelled trollies instead of on a track. Stacking areas between teams will permit a variation in pace. Each team will do one job, eg electrical system, controls, instrumentation, brakes, wheels.

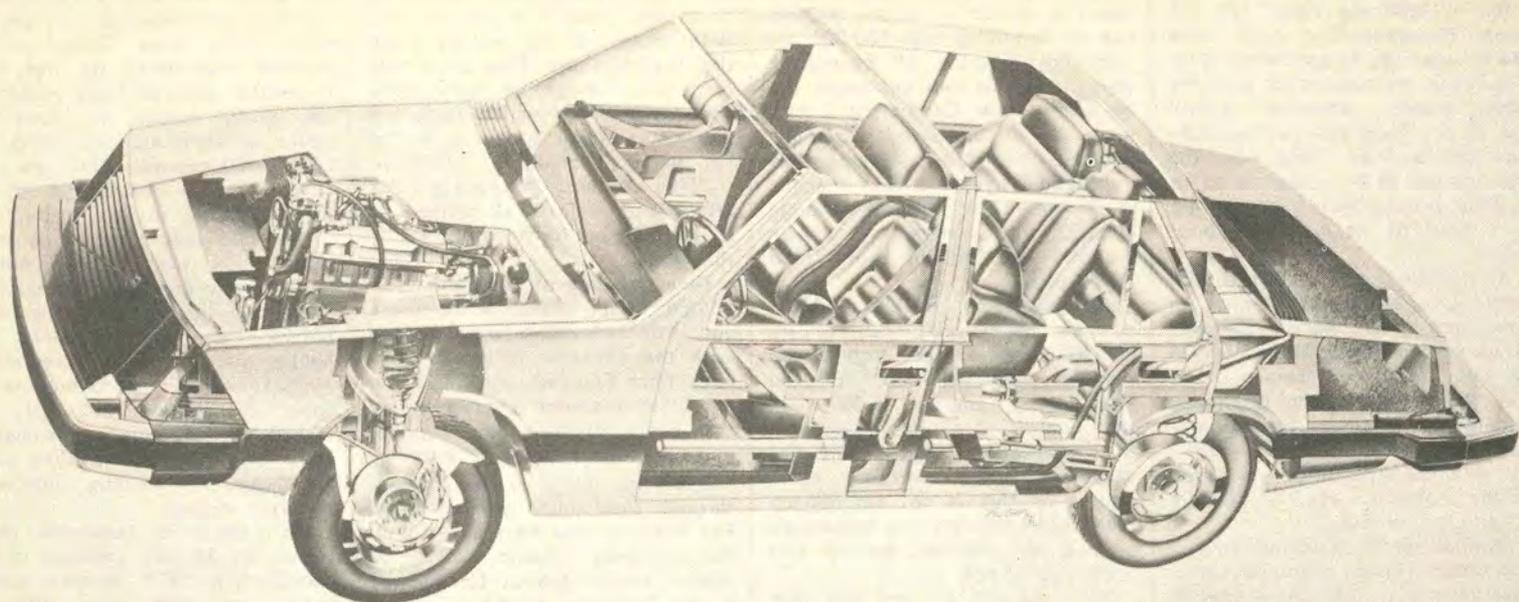
Assembly will be round the outer walls, with material stores in the middle. Electric trucks will carry parts to the teams.

The new plant will cost about 10 million kroner more than a conventional plant but Volvo management think there is every justification for going ahead. G.B.



Above: instant availability of spares and tools in the rectification pit at Torlanda. Below: how job switching can be arranged





By the time the Americans had reached the nadir of their hysteria on car safety and released their ESV requirements, Volvo had long been hard at work on experimental safety cars and road safety in general. Perhaps not surprisingly (there was a lot of inter-discussion at the time and much of the American ESV was based on Volvo experience) when the American requirements became known it was found that of 82 items, Volvo's corresponded to or exceeded 70. Of those items where there was uncertainty or disagreement Volvo have in most cases been proved right. For example, speed sensitive bumpers which protrude further and further with increasing speed are now more or less accepted as being unworkable as well as providing little if any return on investment. Volvo were thus amongst the first to produce experimental (and workable) safety cars, their VESCs (Volvo Experimental Safety Cars).

The significance of the VESC is two-fold. First Sweden is one of the most safety conscious nations in the world: their drink-drive laws, for example, are notably stringent, almost vicious. They are also heavily committed to the American market where again safety was coming under close public scrutiny. The VESCs therefore were a visual and positive indication that they were serious about safety.

The second consideration was technical. The cars were built to see just how practical a near enough total safety concept was, and to try out various safety items under controlled conditions. Hence each of the cars built is slightly different, and where there are variations they will be discussed here.

There is one other aspect of safety with which Volvo are deeply involved. One of the major gaps in designing for safety is the sheer lack of knowledge of accident situations—what actually happens in an accident, as distinct from laboratory situations. Volvo recognised this quite early on in their studies, and in 1967 instituted a 28,000-accident survey,

SENSIBLE SAFETY

Volvo were well ahead of the game when the Americans became acutely safety conscious. Mike McCarthy explains

Skeleton view shows impact resistant bumpers, collapsible sections and passive restraint systems on one of Volvo's safety fleet

following this up with a much more detailed investigation into fewer accidents in 1972. Some of the results were published in March of this year as part of the analysis programme, and focused on the value of various restraint items such as belts and head restraints. As might be expected it shows that the mean injury reducing effect of belts is 32 per cent for the driver and 36 per cent for the front seat passenger.

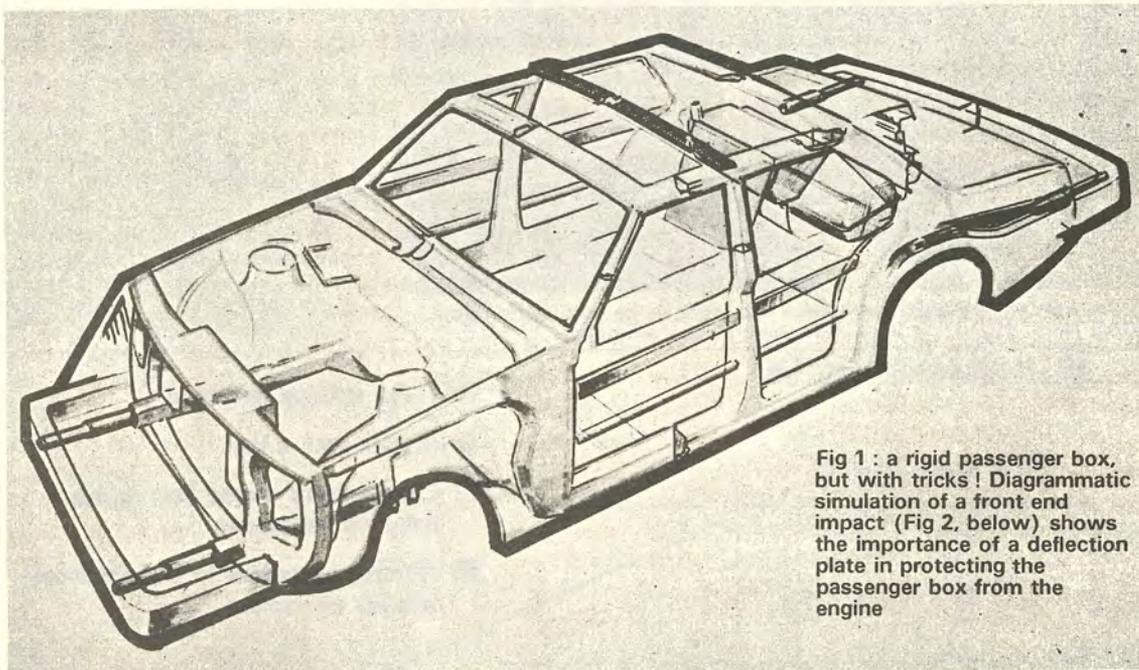
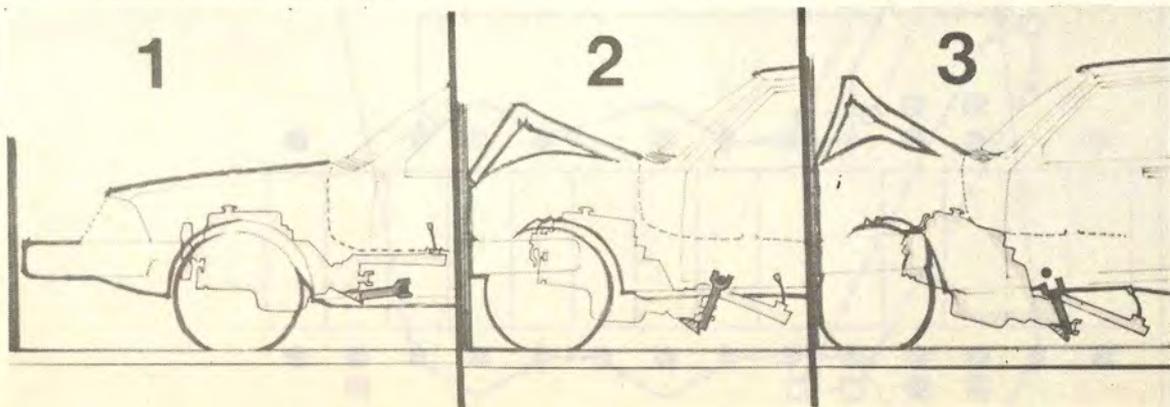
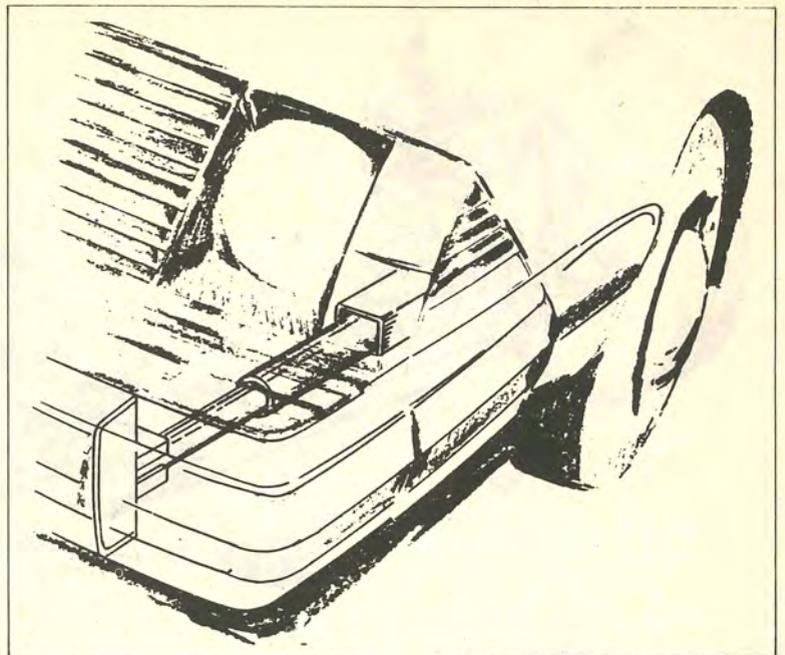
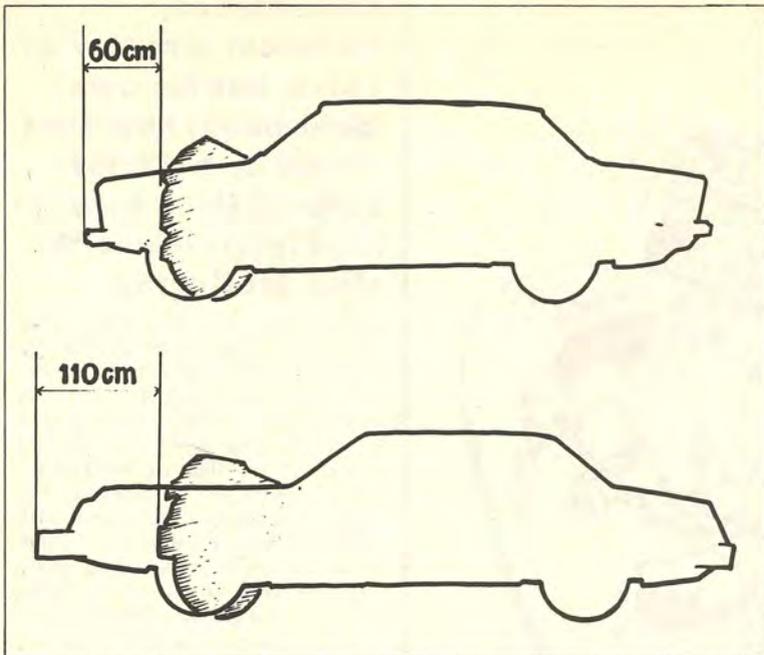


Fig 1: a rigid passenger box, but with tricks! Diagrammatic simulation of a front end impact (Fig 2, below) shows the importance of a deflection plate in protecting the passenger box from the engine



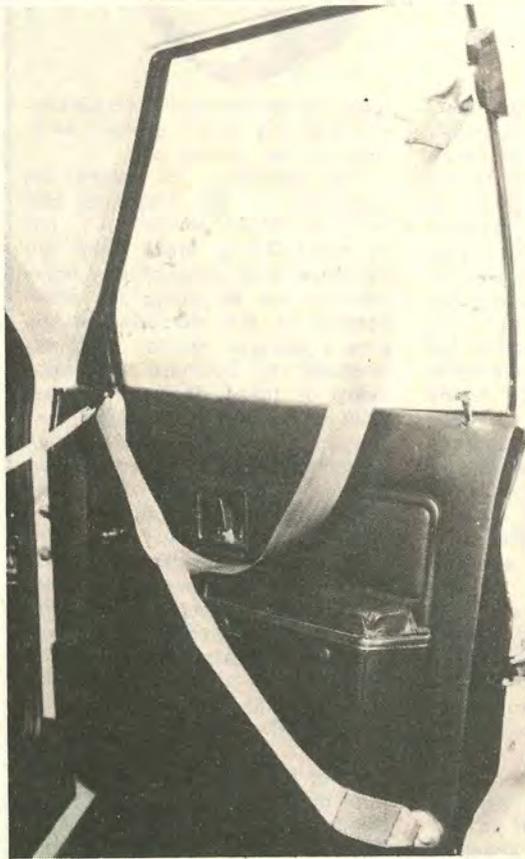


but as the authors say, for various reasons connected with data collection, "the resulting true injury reducing effect should be higher than indicated by the figures. . . ."

To get back to the cars, there is in fact very little that can be said to be revolutionary about them, but then they were meant to be practical. The most important and basic part of any safety car is the bodywork, and that of the VESC is no exception (1). It is based on the deformable ends/rigid passenger compartment idea, but with a few tricks here and there. For example there are structural beams running along the top of the wings and into the base of the A-pillar (the windscreen pillar). These transmit forces through to the roof and into the door at waistline level. There are additional tubular reinforcements in the doors which, apart from acting as anti-intrusion members in the event of a side impact by hooking into their respective door pillars, combine with the beams in the doors at waist level to hold the door aperture constant: plugging the hole, as it were. A fairly common feature of accidents is failure of the joint between the A-pillar, wheel arch and scuttle: using the door as a structural member (as in aircraft practice) prevents this collapse. Thus the passenger compartment is truly rigid, allowing the deformable ends to crush controllably.

Apart from the anti-intrusion members in the doors there is a fairly hefty structural cage around the passenger compartment which include the A, B and C-pillars (the windscreen pillar, door pillar and rear three-quarter post) with a roll-over bar and added reinforcement at the B-pillar. The structure incorporating these pillars is pressed in one piece to lessen the risk of joint failure. There is a deflection-plate floor board which, in conjunction with pivoting engine mounts (2) push the engine down below the floor. On the version to which air bags are fitted there is a cross-member between the B-pillars behind the front seats for yet further side protection.

One important feature is the



An increase in the crush zone (Fig 3, above left) is helped by the massive bumpers mounted on shock absorbers (Fig 4, above right)

One restraint system is "semi-passive" (Fig 5, left) which fits automatically but is removed manually

These head restraints (Fig 6, left) pop up in a crash to aid rear as well as front occupants

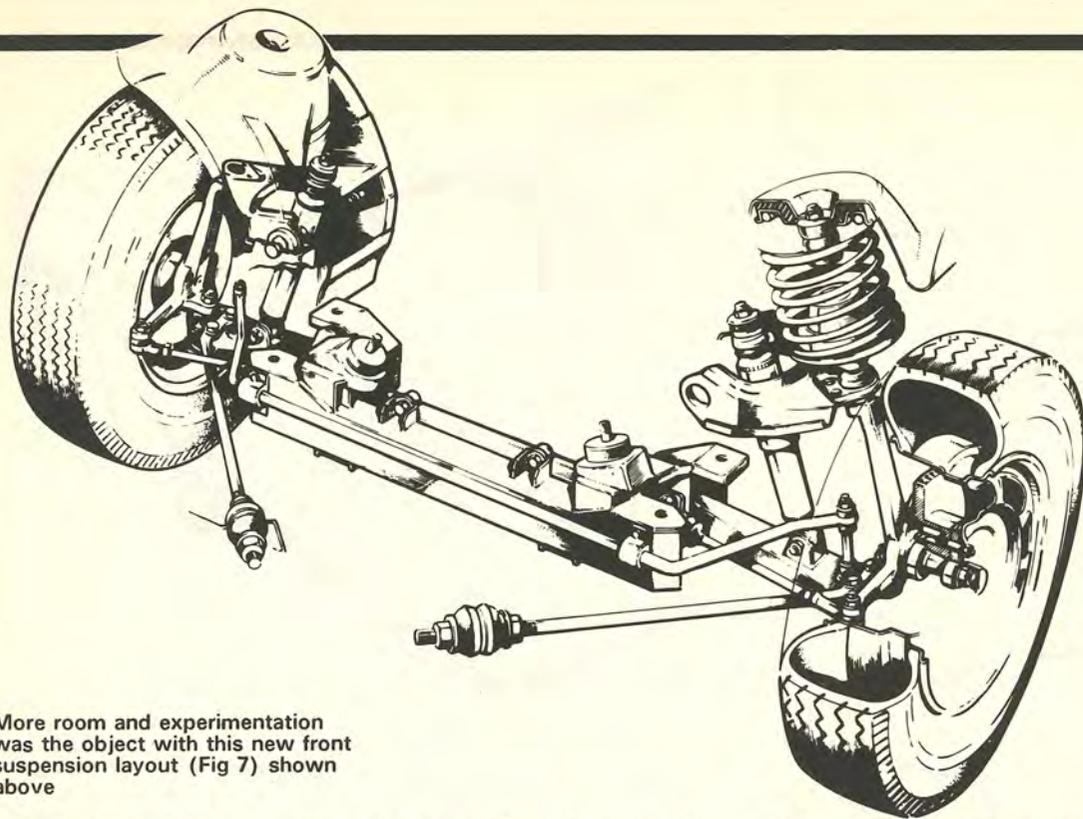


additional length of the VESC over the normal 144. If stress on the human body is not to be too high, accelerations (or decelerations) must be kept below a certain figure. What that figure is is not quite clear, but it was arbitrarily set to 80g for the head and 60g for the breast in a head-on barrier test at 80 kph, which in turn requires a distance of 150 cm of passenger/driver movement. This can be achieved by increasing the crush zone from 60 cm to 110 cm (3). As can be seen, part of that zone includes the front bumper, which in the case of the VESC are particularly massive affairs mounted on telescopic shock absorbers (4).

After the bodywork, the interior passenger compartment came in for a lot of attention, the idea being to "tame" the g-forces applied to the body. Two restraint systems were incorporated, one being as expected an air-bag arrangement with bags in the facia, behind the front seat (as head restraints for front seat passengers in the event of a rear collision, or as normal bags for back seat passengers in a frontal) and behind the rear seat as head restraints. The other was an ingenious "semi-passive" belt system whereby the belts come into action automatically when the engine is started and the hand-brake is released, but which have to be manually removed. When removed the lap and diagonal portion of the belt is clipped to a catch on the door. Sitting on the seat and closing the door activates a retractor on the floor and at the same time releases the catch: sensors in the seat and either the door or the belt start the process. Simple and clever (5). On the same model bolstered front seat backrests hide pop-up head restraints activated by a collision either from the front or back (6). There was protective padding at hip height in the front dorsi.

Another innovation was a "disappearing" steering column. When triggered by an explosive bolt during a crash the steering wheel moves forward 150 mm under spring loading, away from the driver.

The suspension has one or two



More room and experimentation was the object with this new front suspension layout (Fig 7) shown above

interesting novelties as well. That at the front is at the coil spring and wide-based wishbone type, (7) and is more an attempt to get room and try a different layout than for any handling or roadholding reasons. The rear suspension consists of a live axle located by five links, and one of the VESCs has a levelling control consisting of a bellows-type airspring. A switch senses the distance between axle and body and, with the aid of an electric air pump, maintains this distance constant no matter how much load there is on the car. (For headlight levelling alone another car has an hydraulic alignment system controlled from a "black box" at the rear suspension.) The resulting driving characteristics were worked out at the design stage with the aid of a computer.

In primary safety (accident avoidance) Volvo's parameters are stiffer than both the American and German ones, taking in for example anti-lock brakes. Where steering ability is concerned the VESC requirements lie close to the American in terms of lateral-g acceleration with a given radius

circle and speed. Dynamic reactions have been given a higher priority and thus there is better damping (a quicker return to the straight when the wheel is released in a turn, for example. For this reason the handling properties are near the limit of what is considered acceptable by the American ESV standards. The American demands are met in full with regard to other requirements such as directional stability in side winds and self-castor effects, while the VESC will negotiate a slalom (zig-zag) test at speeds of 100 kph plus, where the ESV requirement is only 72 kph.

One of the cars is fitted with a German-made ATE anti-lock brake system. Sensors in each wheel provide a speed signal to an electronic unit which decides through programmed settings, if the wheel is tending to lock. This in turn signals a modulator which drops brake line pressure until sufficient rotational velocity is restored, when pressure is re-applied. The system can cycle at 10 times a second, and is fail-safe in the sense that should a defect occur the anti-lock arrange-

ment is automatically disconnected and the brake system functions in the normal way.

The engines, as might be expected, are the 4-cylinder B20 units as fitted to the 144, but in non-polluting form. They are equipped with exhaust gas recirculation, an air pump for afterburning of the HC constituents, plus a catalytic reactor. They are intended to evaluate the feasibility of these devices for possible production some day (8).

Apart from the major design characteristics as outlined above there are a number of devices which are probably more in the production than in the experimental stage. Headlight washers and wipers are already obligatory in Sweden, and a novel rear window wiper/washer which spreads a curtain of water over the entire window is a good idea. Warning lights in the doors switch on automatically when they are opened.

What lessons have been learnt from the VESC project? The most significant must be that voiced by Rolf Mellde in the interview that follows: that it shows just how impractical and above all costly a car such as this is to produce. Obviously no figures can be quoted, but the added weight of the body compared to a standard 144, the complexity of the bumper arrangement, the sophistication and complication of the safety features all mean added cost, the benefit of which may be only marginally better than that of the standard model.

There has been, though, a fair degree of spin-off applied almost directly from the VESC to the production cars; deep section shock absorbing bumpers, albeit much simplified compared to those on the VESC (they are really for different requirements), a four-stage impact absorbing steering column with a bellows arrangement so that the wheel aligns itself with the driver's body, and a solid steel bar running along the door length for improved side protection.

Rolf Mellde, technical director of Volvo, has his own ideas about how cars should be built. He outlines them here in an interview with Mike McCarthy...

Rolf Mellde could almost be called the engineering brains behind the Swedish Motor Industry, for he has been Technical Director of Saab as well. Born in 1922, he graduated in engineering from the STI in Stockholm in 1942. He worked for Bergsbolagen in Lindesberg and Skandiaverken im Lysekil until 1946 when he joined Saab in Trollhaettan as an Engine Designer. Two years later he was appointed manager of the Testing Department.

The Saab Sonett, widely acclaimed when first introduced in 1956, was largely of Mellde's design. In 1957 he was sent to America to help in expanding Saab's sales organisation there, and in 1959 was appointed Manager of Quality Control. Later in the same year he was appointed Chief Engineer and in 1969 was made Technical Director. He was Project Leader on the 4-stroke 96 before it was introduced in 1966, and was responsible for the 99 project. He has now been with Volvo for some 18 months.

In earlier years he was successful as a competitions driver in both Europe and the USA.

MM: Volvo have an enviable reputation for quality and reliability: why do you think this is?

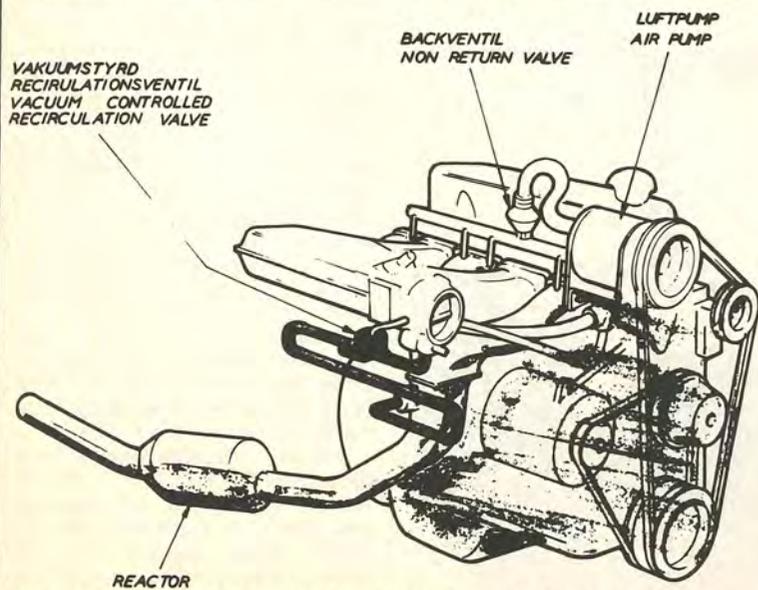
RM: We try and be a little bit better, even if it costs a little more—reliability and quality are two of the main points in our basic philosophy. Car life is becoming more and more important, for two reasons. People don't like working on their own cars (it's a messy business) and secondly service is becoming more difficult—labour is very expensive. We feel that in the future it may be cheaper to, for example, change an engine rather than strip it—the cost of the latter may be more than the former.

MM: Do you think engine components and accessories will become simpler in the sense that, for example, we will see "black boxes" which control a variety of functions—injection, ignition, brakes and so on?

RM: At the moment it is difficult to find economic and performance advantages for electronic components, but there are indications that fully integrated electrical systems should pay off. One problem is to introduce them all at the same time and there is still one other basic point to be solved—we need a really good cheap diagnosis system. The two must go together. We do in fact use a form of diagnosis system here on the line.

MM: Why did you change from the Bosch fully electronic fuel injection system to the more mechanical KA-Jetronic system?

RM: The biggest advantage of the KA system is that it measures the airflow directly instead of using



Exhaust gas re-circulation, afterburning and a catalytic reactor are used for evaluation on 144 engines (Fig 8)

Reliability and quality... our basic philosophy



Technical director Rolfe Melde

parameters, which means that the engine is better on emissions and, very important, it is easier to service—it is not so complicated and the electronics have been simplified.

MM: Turning to emissions, can we make present engines cleaner without a complete redesign?

RM: This is the big question—we just don't know. There are at least two possible ways to go. The first is to use some form of feedback system, and the second is stratified charging. In the first, sensors in the exhaust pipe will measure pollutants (which ones we don't know yet) and feed the information back to some form of fuel injection system to adjust the characteristics accordingly. Engines must become more efficient, less polluting and more economical. Stratified charging is one of the most promising developments, but power loss is a disadvantage.

MM: What about 4-valve heads?

RM: They are not a complete answer, but they may be part of one. It's like lean mixtures—the only successful way to run lean is by stratification, but there are many other systems around.

MM: And the Wankel?

RM: It is hard to see that this is a real solution. The big advantage of the Wankel is that it is so much smoother—and perhaps it is lighter and takes up less space. Space that could be used for crushability.

MM: Volvo have probably more experience of turbocharging than almost anyone else in the world—admittedly on diesels. Do turbochargers have anything to offer on petrol engines?

RM: Could be. They may be

used to bring back power lost by emission controls, but so can a bigger engine. Fuel consumption need not necessarily suffer either—if you can improve the SFC (Specific Fuel Consumption—a measure of engine efficiency). The big drawback to turbocharging is the extra cost per horsepower compared with other solutions. It has more to offer on diesels.

MM: Talking of diesels, where do they fit in?

RM: They are another possible solution. Remember they can meet tough but reasonable regulations already. With the stress in the future on emissions and consumption the diesel scores on both counts.

MM: What about roughness and lower power outputs?

RM: Yes, it has its problems but it can be turned into a good engine—some people (naming no names!) have done so already.

MM: Considering the more general aspects of engine design, can you see any trends?

RM: The importance of the race for power will be reduced, especially as fuel becomes more and more expensive. Efficiency will take over from pure power. They may get a little bigger to retain the same performance, but again consumption is the key word. In the USA engine sizes will definitely come down—it's happening already. We at Volvo are already working with Renault and Peugeot on the design and development of a new engine, but this is still at the study stage—and that's all I can say!

MM: British investigations are showing that collapsible steering columns are not working as well as expected. In your experience is

this so?

RM: No. Our experience shows that steering column collapse is a big safety improvement.

MM: What are your views on safety belts and other such features?

RM: Unfortunately you can never be sure that people will wear belts all the time. I personally feel strongly that, after belts, collapsible columns and high impact windscreens are most important.

MM: How do you feel about anti-lock brakes?

RM: I doubt whether they will be widespread before laws make them compulsory—they are very costly. There is a comprehensive investigation being carried out in Sweden at the moment by the Traffic Safety Authorities on this very subject, but it will be a year and a half or so before we see any results. And the Swedish Anti-lock Brake laws have been postponed from 1975 to 1977 or 1978.

MM: Do they serve a particularly useful purpose?

RM: If you ignore cost, then in most cases they are advantageous. But, for example, they can give longer braking distances in snow. With locked wheels you build up a snow ridge in front of the tyre. Then there is the psychological factor—will people drive faster because they feel safer? But we have to improve all the time, and this is one way to do it. And remember they are at the moment very expensive.

MM: What about the run-flat tyre?

RM: One day we will have to get away from the spare wheel, but what the best solution will be we don't know.

MM: Turning briefly to safety cars for a moment, have you crashed any of the MESC's?

RM: We have studied their crashworthiness very deeply.

MM: How much spin-off can you expect?

RM: Three that I can think of straight off. First the side impact protection, second the bumpers which really work, and third the steering column design. Personally, I feel that one of the best things to come out of the programme was the decision to build the VESC. Now everyone can see for themselves that it is almost impossible to produce, and in that sense it has been successful.

MM: So how do you see production cars changing?

RM: Well, the stronger bumpers are here to stay. Some people may say they look heavy, but we feel they will soon get used to it—particularly if all cars are so fitted. The idea, of course, is to reduce repair costs. As for the future, there will be a lot fewer drastic redesigns—everyone has

done a good job in the past six years. There may be, say, more padding, and with small reasonable improvements we can increase safety considerably. The big question, of course, is the passive restraint system. Statistics show that the belt is the best of all the safety systems—but how do you get people to wear them? I don't believe the Americans will give up the air bag, but the indications are that they are going to be a little more reasonable. For example, they may introduce bags or a small percentage of cars to get experience. We still don't know anything about their reliability or how efficient they are (in side impacts or roll-overs, for example). I cannot see even a good air bag system without at least a lap strap.

MM: Volvo own 30 per cent of Daf: will we see Volvos with Variomatic transmissions?

RM: Not on bigger cars, no. The size of the Variomatic increases too much with increased torque. We will see, though, more and more automatics. Customers are not too fussy as to what kind, so long as they are reliable. They do tend to have a slight disadvantage regarding fuel consumption, but this should not be stressed: drivers and driving conditions can play a much bigger part. But of course they will still have to be improved in this respect.

MM: What developments will take place in suspensions?

RM: I don't see anything too drastic happening—Citroen are still alone with their sophisticated layout. The big question mark hangs over independent rear suspension. Many people think de Dion is best, but it is the most expensive.

MM: Are there any advantages to an IRS?

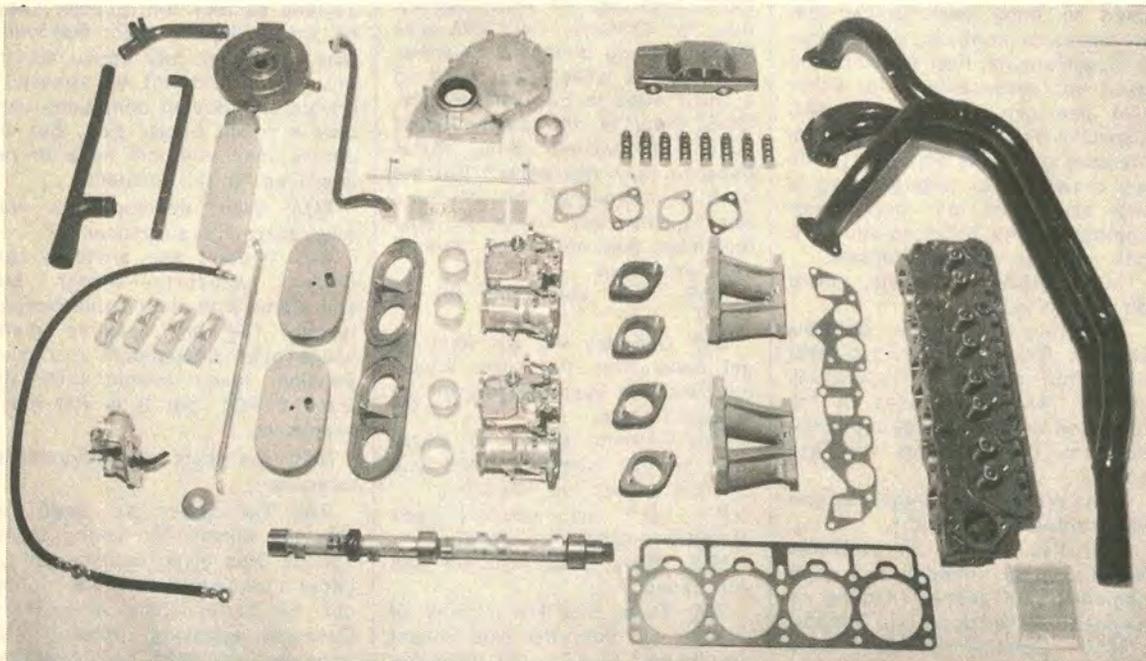
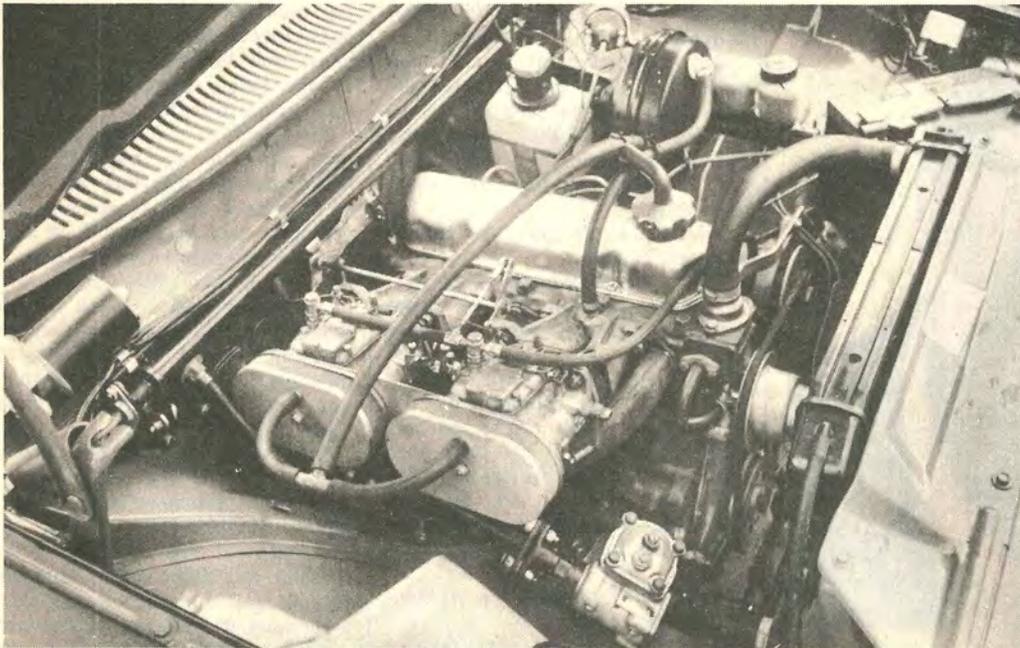
RM: The better the roads the less the reason for having them. The de Dion gives better stability, yet is non-independent. The money can be better spent elsewhere! Generally speaking, present systems are very good. The important consideration here is handling, but that doesn't necessarily require IRS. We believe the Volvo handling characteristics are good, but we are always working to refine them—it's a continuing development. One of the biggest improvements will come in steering, especially lighter steering. We already have power steering even on our four-cylinder models. We use the ZF system which has plenty of feel—we think this is important.

MM: What about the Citroen (speed sensitive) system?

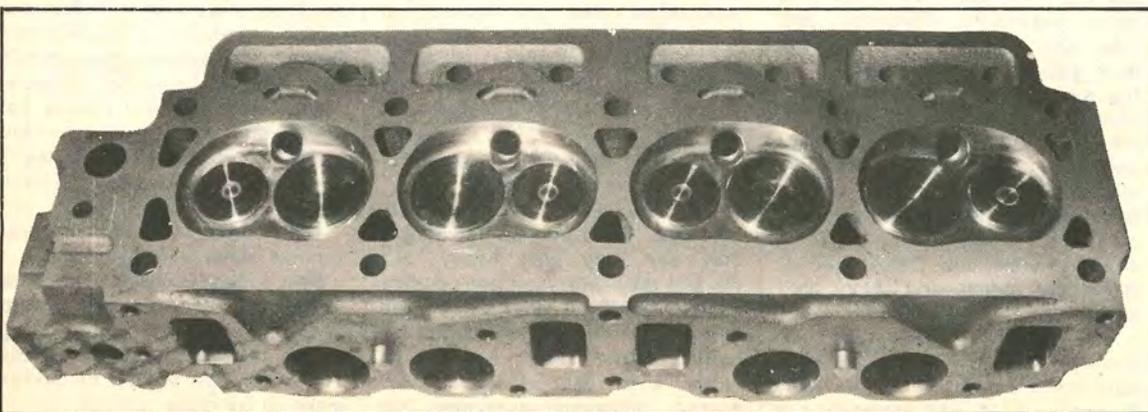
RM: I don't think it's necessary to go that far. We will see lots of improvements and new designs as the hydraulic systems improve. There is still a fair bit of development to be done, though.

THE GO-FASTER DEPARTMENT

Volvo are no longer officially involved in competition but they still sell the goodies, for road and forest



Top: Freely available in the UK, this Stage II kit can be fitted to all B20 engines without spoiling access or appearance under the bonnet. Component parts of the Stage II GT kit (above). The model is extra. A superb standard of machining was noted on the ports and combustion chambers of the GT head (below)



MAXIMUM SPEED		Std 144	144 GL	144 GT
		mph	mph	mph
Lap		91.8	104.0	107.1
Best 1/4 Mile		95.0	104.0	109.7
ACCELERATION				
mph	sec	sec	sec	sec
0-30	4.0	3.1	3.0	3.0
0-40	6.4	5.0	4.7	4.7
0-50	9.8	7.3	6.7	6.7
0-60	14.1	10.3	9.0	9.0
0-70	20.5	14.2	12.5	12.5
0-80	30.7	19.5	16.5	16.5
0-90	—	28.5	23.7	23.7
Standing 1/4 Mile	19.6	17.4	16.9	16.9
Standing Km	—	33.0	31.5	31.5
IN TOP				
mph	sec	sec	sec	sec
20-40	9.7	9.6	12.0	12.0
30-50	9.5	9.5	10.2	10.2
40-60	9.6	9.0	8.7	8.7
50-70	12.1	9.4	9.3	9.3
60-80	16.8	11.5	10.4	10.4
70-90	—	15.5	12.6	12.6
80-100	—	—	19.5	19.5
IN THIRD				
mph	sec	sec	sec	sec
10-30	7.4	7.3	8.3	8.3
20-40	6.5	6.4	7.2	7.2
30-50	6.8	5.6	6.1	6.1
40-60	7.8	6.0	5.6	5.6
50-70	10.4	7.0	6.0	6.0
60-80	—	—	7.2	7.2
FUEL CONSUMPTION				
Steady mph	mpg	mpg	mpg	mpg
30	39.2	*	34.7	34.7
40	36.7	*	33.2	33.2
50	32.5	*	30.8	30.8
60	27.8	*	26.1	26.1
70	23.8	*	24.9	24.9
80	21.1	*	23.0	23.0
90	—	*	20.6	20.6
100	—	*	16.7	16.7
Overall	22.5	19.5	16.8	16.8
Touring	25.7	—	23.8	23.8
*not measured				

In 1966, after many notable successes, Volvo gave up any direct involvement in motor sport. Few enthusiasts need reminding, though, of their strong showings in prestige rallies like the Monte, RAC and East African Safari. However, Volvo's interest in competition matters didn't wane and in 1969, after much badgering from privateers, they set up their own Competitions service.

This department employs about 20 people led by the inimitable Gunnar Andersson, works driver for Volvo in their heyday. It provides a wide range of tuning kits, special accessories and safety equipment.

There are many advantages in having a factory tuning/competition establishment. For instance, the factory can call upon much more expertise, experience and technology than any back-street tuner, and as all the tuning kits are endurance tested on dynamometers, Volvo can vouch for the engine's durability. Volvo's reputation for reliability was not achieved overnight and it's not something that they would wish to tarnish with un-developed or ill-advised tuning.

Until quite recently, Volvo devotees in this country who wanted to go rallying, or just get a little bit extra from their cars, had to liaise with Sweden direct. Far from ideal, that was until Ralph Steiner of Tungston Automobile Developments (TAD) got involved. At the end of 1972 he started importing the Volvo competition goodies direct from Sweden. (Regular Motoring Plus readers will remember the TAD-tuned 144GT that we tested last February.) This one-man crusade for Volvo tweaks in this country created sufficient interest for the

concessionaires themselves to get involved. Now they are making Volvo Competition Parts available to any dealer who wants them. All of these parts will continue to be available (most of them ex-stock) from TAD at 264 Nether Street, Finchley, London N3 1RJ, telephone 01-346 6616.

Basic engine kit

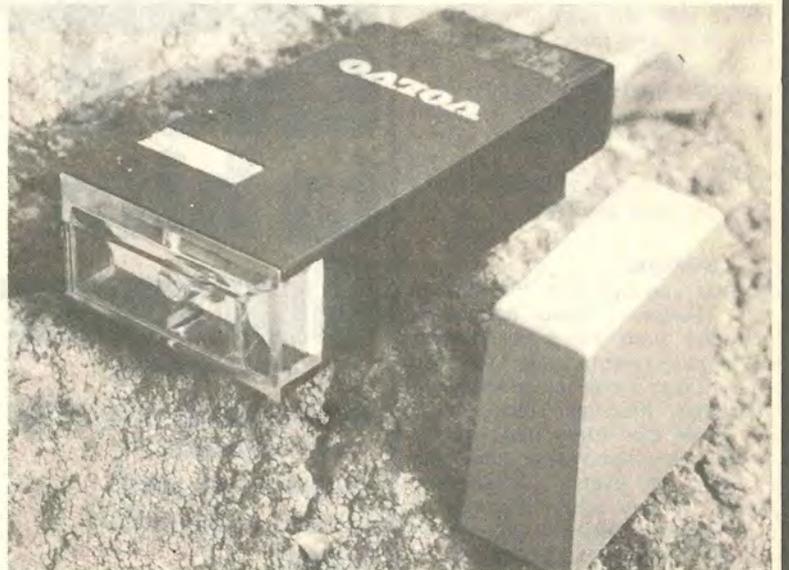
This is called the 144GT Stage II and can be fitted to all B20 series engines from 1969 onwards: It consists of a modified cylinder head with superbly machined ports and combustion chambers, a competition camshaft, free-flow exhaust manifold, a pair of Solex 40DDH twin-choke carburetters, complete with manifolds and linkages, air cleaners, lightened flywheel and all the necessary gaskets, nuts, bolts and breather pipes. With all these bolted to your engine it should give around 140 bhp (DIN) at 6000 rpm, compared with the 82 bhp at 4700 rpm of the standard 144 and 124 bhp at 6000 rpm of the much more expensive GL. Bought on an exchange basis this kit costs £302.50. Fitted to a new 144 the total package costs £2510.00 from TAD (a standard 144 costs £2195) which is pretty good value when you consider that the slower 144 GL—admittedly more luxurious—is listed at £2850. Incidentally, the Volvo warranty isn't affected.

Other engine modifications

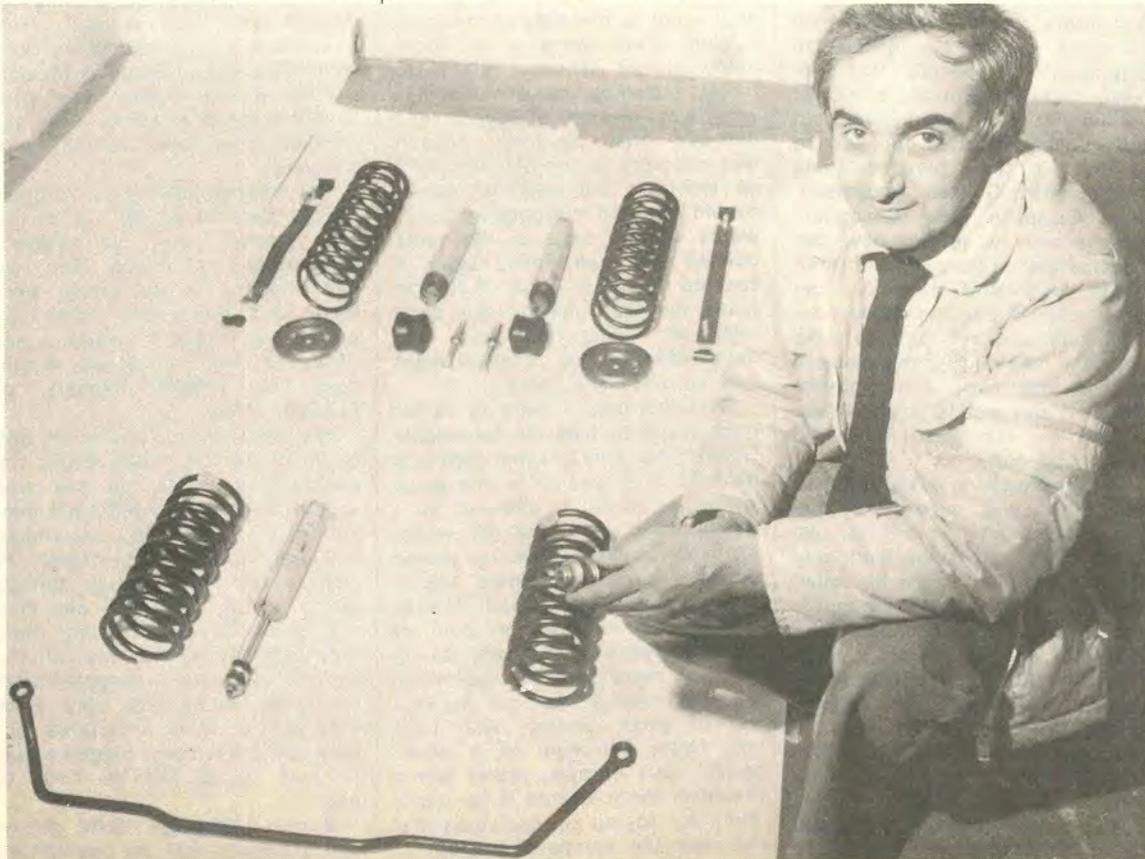
Also available from TAD as separate items are a lightened flywheel (steel), a lightened flywheel (alloy and weighing a mere 3.5 kg or 7.8 lb), an "R" camshaft (hotter than that fitted in the GT kit), close ratio gearbox and parts, a 4.88:1 limited slip diff, and a choice of steel or alloy sump guards to protect the engine when the going gets rough. Apart from the steel flywheel and camshaft these have to be specially ordered.



A welcome degree of extra precision had found its way into the TAD modified 144GT tested (above). Saab do it one way, Volvo another—wipers on the headlamps (below) of the TAD car



A re-chargeable hand flashlamp (above) is among the TAD goody stock, while (left) Ralph Steiner shows the road/rally suspension kit



Complementary GT equipment

To go with the engine mods there are a number of other accessories to bring the rest of the car up to spec. These are an instrument panel for pre-1972 cars (£66.00), GT steering wheel (£27.78), gear knob (£3.17), 5J and 5½J alloy wheels (£27.62 and £31.42 each, respectively), front shockers (£6.42), rear shockers (£6.72), as well as a selection of stripes, hub caps and chromed wheel nuts.

Suspension and brake kits

If you want to improve the suspension further there is a choice of two kits. The first is the "road rally kit" which consists of, for the front, DeCarbon dampers, springs and a 20 mm anti-roll bar, and for the rear, DeCarbon dampers, spring sets and reinforced axle rubbers. This lot will set you back £160.60 including VAT. For rough-stage rallying TAD can supply the "rally competition kit" which has the same parts but with the addition of reinforced rear suspen-



Frivolous? A shirt and sun hat, nicely modelled

sion arms, front lower A-plates and shocker mount bolts.

We recently tried a TAD 144GT with the road rally suspension parts and found the handling much more precise and the transition from understeer to oversteer near the limit of adhesion is much more progressive on dry roads.

Uprated front and rear brake pads are also available.

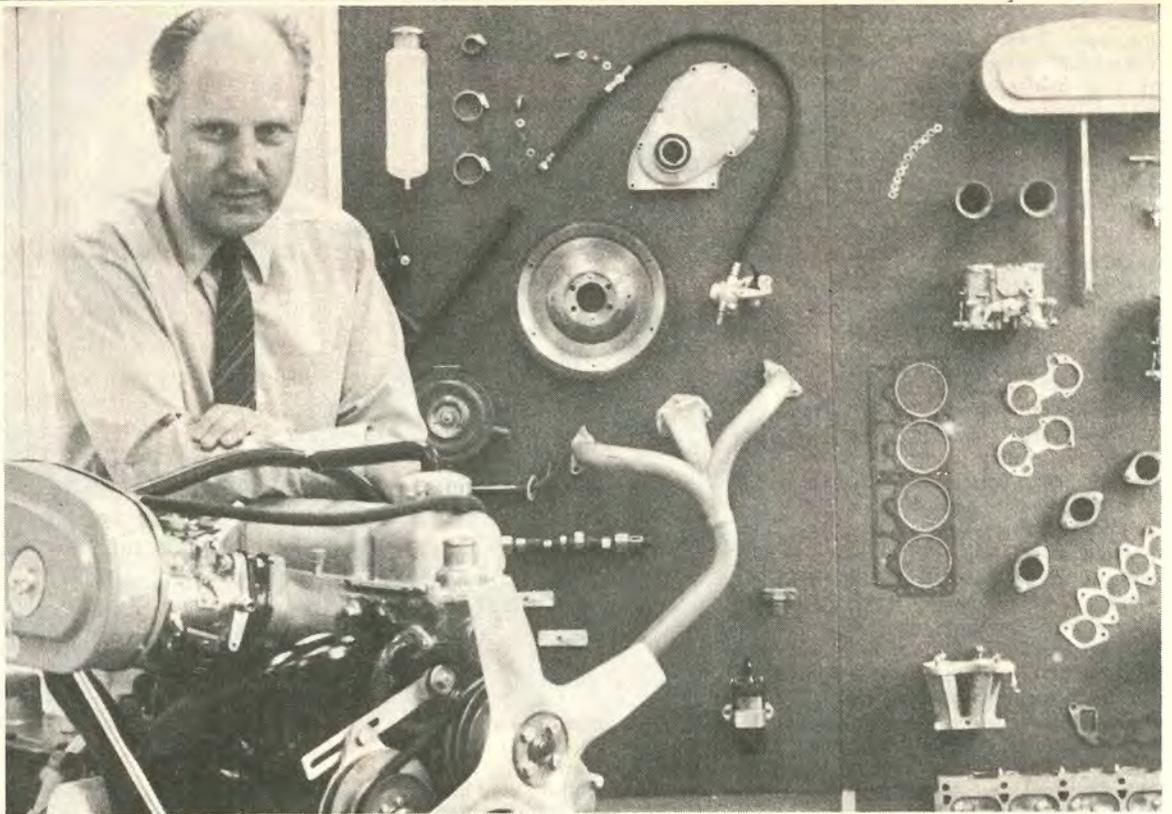
TAD boutique

So that you can look the part as well, Tungston have opened a boutique from which all manner of accoutrements can be had. These range from the practical to the—well, frivolous. Top of the list come the Volvo Rally Jacket which has a removable lining and all sorts of useful pockets and things to play with; it's one of the best rally packets we've seen but then it ought to be for £25.08. For summer wear there's a light-weight jacket which costs £8.98, and a T-shirt for £1.94. And if you really want to look foolish around the paddock you can keep the sun off your neck with a Panama Hat (44p).

Rex Greenslade



Serious? Never! Greenslade in the £25 rally jacket



Former European rally champ Gunnar Andersson with the competition kits Volvo sell to dealers or owners

Give it to him Gunnar

In which George Bishop goes yumping with Gunnar Andersson and moves a Swedish forest

The Editor could hardly contain his mirth as he put down the telephone. "It seems that the Volvo proving ground is closed and you can't go there" he said "so I have arranged for you to go out in the Swedish pine forests with Gunnar Andersson, twice European Rally Champion, and see how he tests a new car. It seems that in keeping with their quality programme they give him a new car off the line every now and again and tell him to take it out and break it. For this purpose he has his own little private circuit of dirt public roads where he can go very fast. It should make good copy."

He was chuckling because not so long ago I was exposed to the pine forests with Per Eklund, one of the Saab rally kings, and only just climbed out before he rolled the car. I suppose the yumpers now regard me as The One Who Got Away and aim to put it right. "You'd better get a photographer laid on this time" said the sadistic editor, remembering that last time I ran out of film at the crucial moment when the sods were flying.

Well, it didn't work out quite like that, although a very good

time was had by all. The man who should have looked after me that day was taken ill at the thought and instead I was left in the hands of Alex Roussakoff, who likes with good reason to call himself The Mad Russian. Alex was with General Motors for years and has some odd friends, including a man who lives near Bedford, England, and keeps 50 dogs, which he takes with him when he goes to the local pub. Yes, I did say 50 dogs. I suppose he must be a master of fox-hounds or a beagler or something, but Alex insisted that they walked to the pub with this pack of canines, and whenever a car came along the man just said quietly "over" and all the dogs went to one side of the road.

Well, there were a lot more funny stories which I prefer to forget, including one about a man who was making a speech and declared that Swedish aquavit was not very strong. At this point he leant on the batwing doors behind him and disappeared backwards without trace as the doors opened and then closed again. It seemed funny at about 3.30 a.m. when we were having our early night as I was tired after two days' solid driving, a short night and an aeroplane flight.

Next morning I was in rather poor shape to face the formidable Gunnar, but due to some technical hitch he was waiting in one place while we were at another, so I had a little ziz in the car which probably saved my life. He turned up in a souped-up Volvo 142 in custard and black, and I was pleased to observe a pair of battle bowlers in the back, as on my last experience no hats were supplied, and a man got his hair full of glass. Gunnar, who took my fancy at once as a quiet, impish sort of man, rather like a Swedish Innes Ireland if he won't mind my saying so, explained that he runs the competition side.

This needed a little explanation as they don't compete workwise, but he produces special heads, camshafts, suspension bits and so forth which they sell to would-be racers and rallyists. The standard 142—this is the two-door—should have 125 horses and his kit adds 40 more. Then there is a stage two with polished head which is even hairier. All will be on sale in England soon.

My head was not very polished that morning, and when Gunnar suddenly leapt in his car and spun it round and round on a sixpence with all the tyres smoking and howling like trolls it didn't help. He apparently enjoyed it though instead of breakfast, which he doesn't take. Just as well. Then he explained about the Volvo Cup, which is a sort of Swedish Mexico Racing, if you follow, but with Volvos instead of Fords. They are identical cars tuned to the same standard.

The other popular sport is forest racing, and maybe 60 out of the 180 starters will be Volvos. Apparently the young men are queuing up to go racing over there, but Volvo are rather out of the big league in which a hot BMW or Capri in Group II will cost you 130,000 Kroners, or £13,000. Wow.

We were at this point at one of the three test tracks which the company run. The big one was shut to visitors, but this little five-kilometre track had everything, including humps of tar about 18 inches high and a wavy surface which makes the MIRA one look like Bond Street. The only thing that bothered me was the vultures sitting on the lampstandards watching. Admittedly they were only mini or Mark II vultures, but they had those nasty jagged edges to their wings like all birds of prey.

Gunnar drove me round gently, and explained that we couldn't go



A yump in close-up ! Trolls burrowing under the Torslanda proving ground make them Left : the author with car plus mirror for solo checking of lights

radio, seat belts, wipers on the headlamps, and these 24 metres weighing 52 tons behind me, and a grinning Gunnar alongside.

I noticed in the rally car that he always had the brakes on long before I did when I was driving, but was far too busy in the truck to watch anyone's feet. Amazing ! The super-juggernaut has light steering like a small car, and light pedal pressures too, and a lighter clutch than any muscle car. And an easy gearchange, although I didn't get past fourth. It's all so easy—oh, hell where's the trailer gone ? Hey, Knut, you'd better take over, there's a corner coming.

Volvo, you will all remember, is Latin for "I roll," so a word to the wise is enough. Oh, and by the by, there's a Saab with a Volvo engine. It's called a Vegan and is a superfast military aeroplane. Thought you'd like to know.

out on to his semi-private circuit in the forest (God be praised) because he hadn't been given enough warning to get it all policed so that we could go fast in safety. The little test track, right next to Torslanda so that they can take cars off the line there, is a marvel, with automatic lamp posts which collapse gently upon impact, and lights which turn from green to red when there's ice about. Which is mostly. There's also a workshop at the track so that faults can be rectified on the spot, and all kinds of cunning devices.

Gunnar then said we should go to lunch and would I like to drive his rally car but please keep it under 7500 rpm. I had some difficulty with the gearchange, and he said Ah ! I was demonstrating to 200 American dealers in a quarry, or at least that is what we worked out it was in English, and I hit some stones and tear off the sump guard and push the gearbox sideways a little and as you see broke the speedometer but it is nothing.

After lunch I was regretting a

little less my visit to the Mirabelle and Old Jackies the night before (who said the Swedes are dour ?) when they produced this 52-ton seven-axle truck-and-trailer 24 metres long, which must be eighty feet. It had 26 wheels, 36 tons of Swedish pine forest on the trailer and the balance on the truck itself. The Knut behind the wheel came from the North, and he moved the slice of forest to a quiet place for me to have a go. A sporting sort of chap.

The driver's seat was up a ladder on a level with my nose. There were 16 forward speeds achieved by two gearboxes and a two-speed axle. It made the so-called juggernauts look like Dinkie toys. Above my head was a cord like in a locomotive, and when you pulled it it made a noise like a locomotive. The tyres were Michelin X 12 x 22.5. There were four pedals, one for engine braking. I could not understand how that one worked, but it caused a chuffing noise, so maybe they put compressed air in the engine or something. I was too scared to worry about that.

There were comfortable seats,

Bishop pokes a quivering elbow from the cab of a 16-gear, 52 ton Volvo monster (below). Burnham Woods bound for Dunsinane ?

