JAGUAR

PRODUCTION

and

QUALITY CONTROL

JAGUAR CARS LIMITED · COVENTRY · ENGLAND

PRODUCTION OF A JAGUAR CAR

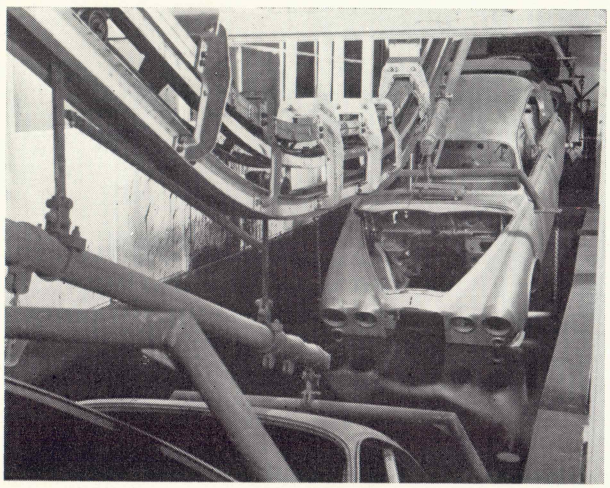
The production of Jaguar cars is a lengthy operation involving the employment of some 7 thousand workmen operating in two factories, each of over $1\frac{1}{4}$ million square feet, and using equipment worth many millions of pounds. The Jaguar Organisation produces approximately 625 cars each week, of which 51.2% are exported. The Company has a world wide sales and service network operating in 126 different countries. There are 134 distributors and 960 dealers throughout the world handling Jaguar products. The Company's largest market is the United States of America with the Continent of Europe rivalling it very closely in second place.

Ever since the end of the war, the world wide demand for Jaguar cars has steadily increased and the Company's production facilities have been expanded to meet it. The emphasis, throughout the factory, is on quality and it is interesting to note that one in eight of the production staff is an inspector of quality. The Company possesses two factories in Coventry—one at Radford for the manufacture of components and sub assemblies, the other at Browns Lane where the cars are assembled, tested and despatched.

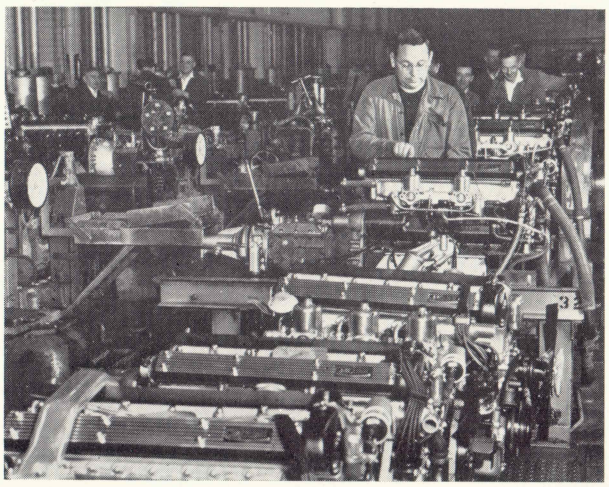
Jaguar do not possess any foundry facilities and, as a result, forgings and castings are produced by outside suppliers. Any component or raw material purchased from outside sources is the subject of meticulous inspection routine before being passed to the machine shops or assembly tracks. These inspections are, of course, additional to those carried out by the suppliers themselves. In the machine shops at Radford are produced all the components for engines and gearboxes together with many hundreds of other items ranging from cylinder head studs to suspension wishbones. Crankshafts, flywheels and connecting rods are all machined and balanced to extremely fine limits and these, together with all other minor components, are the subject of a detailed inspection before assembly.

The assembly of the engine is carried out on a single track and each operator performs a set series of tasks. The actual assembly of the engines is relatively straight-forward and attention is focussed on the care with which they are assembled. Items such as crankshafts and flywheels which have been balanced individually, are now rebalanced as one unit. Connecting rods are sorted into sets of six by weight and length, and only the minutest of variations is allowed. Pistons too, are graded for diameter and sorted into sets of six by weight. An interesting point is that each cylinder bore in a block is measured to extremely fine limits to enable exactly the correct grade of piston to be fitted. When the engine has been assembled it is fitted with the appropriate clutch and gearbox—the latter also having been carefully assembled and checked. From here the combined unit goes to the test house where each engine is run on a dynamometer for approximately six hours at various speeds and loads, finishing with a short test to check power output etc. Throughout this period clean, filtered oil is circulated through the units which, after test, are taken to the car assembly factory.

Meanwhile, at the Browns Lane factory, the body shells have been rustproofed, primed and painted in an extremely modern paint shop which is temperature and humidity controlled, as well as free of dust. There are 39 different stages to the process in which 3 primer coats, one sealer coat and three



After inspection and zinc phosphate rust proofing bodies are passed through a 'slipper dip' of anti-corrosion paint which gives added protection to the lower panels of the body.



During the six hour run on a dynamometer in the test house each engine is subjected to a short power output/performance test, when fine adjustments are made to carburetters, ignition timing, etc.

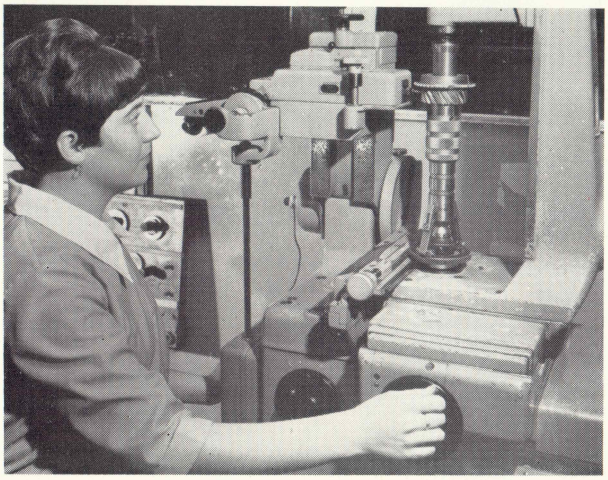
colour coats form the main finish, and these are additional to the undersealing and complex processes of rustproofing which preceed the main painting operations. A synthetic enamel is used which is baked in gas and electric ovens to produce an extremely hard paint finish which is both extremely resistant to scratching and colour fading, yet has a brilliant finish which will last with the minimum of attention. It is important to note that the final colour coats are applied in a separate paint shop, and only after all assembly and testing of the cars has been completed.

From the paint shop, the bodies proceed to the assembly area. Here they are put on a slow moving conveyor and the assembly processes begin. The electrical equipment is installed first, followed by such items as windscreens, door frames and windows, and interior headlining. At this point, the partially assembled body meets all its mechanical components which, in the absence of a separate chassis, are laid out on a special fixture forming part of the assembly tracks. The body shell is lowered over the mechanical units and the second assembly stage—that of fitting all the mechanical units into the body—is begun. Only when all mechanical units have been fitted does the car pass on to the trim track—stage three in the assembly process. Here the interior trim is fitted—seats, carpets, woodwork etc.—to make up the finished car. Unlike most manufacturers, the fitting of the luxurious interior is only executed when all mechanical work has been completed. This is a much more expensive method of assembly, but the final result amply justifies the increased cost. At the end of each of the stages outlined above, there is a complete inspection of all work carried out during that stage, and the car is not allowed to proceed until it has been passed by the inspectors. In addition random checks are carried out continuously by other inspectors who pick on any car at any stage of assembly to carry out further checks.

From assembly the cars are passed through to the test department where an experienced tester—one of a team—takes the car out on the road and completes a full report on its behavior and characteristics. The car is then returned to the department where any adjustments required are carried out, after which the car is taken out again and retested by another driver. When passed by the test department the cars then proceed to the final line where a team of inspectors carry out a minute and critical examination of paintwork, chrome plating, upholstery and woodwork. Any defects are removed. and the car is then prepared for the final painting operations. The body is rubbed down by hand and, after masking, enters the spray booth where the final coat of paint is applied. The paint is then dried in an oven and after, a further inspection, the trim, rubbers, bumpers etc. are re-fitted. This process, which is both very costly and time consuming, is employed solely to ensure the highest possible standard of paint finish.

Finally the cars are thoroughly cleaned and polished and, after a final inspection, are fitted with their equipment (tools, spare wheel etc.) and passed to the despatch department.

The whole process takes between 6 and 8 weeks. Each car is made to individual customer's orders and several thousand different variations in specification are possible without repetition—an indication of the wide choice open to the Jaguar customer.



Gearbox components are crack detected and then measured to ensure that they are within the tolerance limits.

The trimming of cars is undertaken by highly skilled craftsmen who, to ensure uniformity within each car, select hides of matching grain and colour.

QUALITY CONTROL AT JAGUAR

Quality control is of prime importance in the manufacture of all goods—consumer and durable—and nowhere more so than in the world of wheeled vehicles—particularly cars. The institution of a system of quality control in itself presents relatively few problems—by far the biggest headache is establishing a **standard** of quality for several thousand parts of widely differing materials, functions and design. Each standard has to be related not only to the function of the part itself, but also to its relationship with other parts in the same assembly or same funtion. Too high a standard means excess cost and an uncompetitive final price, too low a standard has obvious results, and a lack of quality uniformity over the whole range of parts results in an unsatisfactory performance by the finished product. The establishment of a uniform standard of quality can be achieved in part by empirical methods, but in the end relies on a vast reserve of knowledge stemming from comparative information of quality standard against realised performance in use. Above all, it must be appreciated that, in a complex product such as an automobile, no amount of quality control can 'build in' the feature of quality. The quality has to be there at the start, and must be built into the product by the workers employed to assemble the product. By far the most important feature in this respect is operator experience, and Jaguar is particularly fortunate in this respect, for total concentration on the quality type of car has enabled the Company to build up a workforce in which pride of workmanship is a major factor. A brief resumé of the Company's activities in the quality control field is added below. With a total workforce of 7,500 one in eight is wholly employed in the quality control field.

Raw Materials

All raw materials—e.g. bar steel and sheet steel, forgings and castings, pressings, upholstery materials paint etc., are comprehensively checked by the manufacturers. In addition, Jaguar take samples of all batches of materials and submit them to their own laboratory inspection and test. All materials have to pass this inspection routine before being passed to the various manufacturing units.

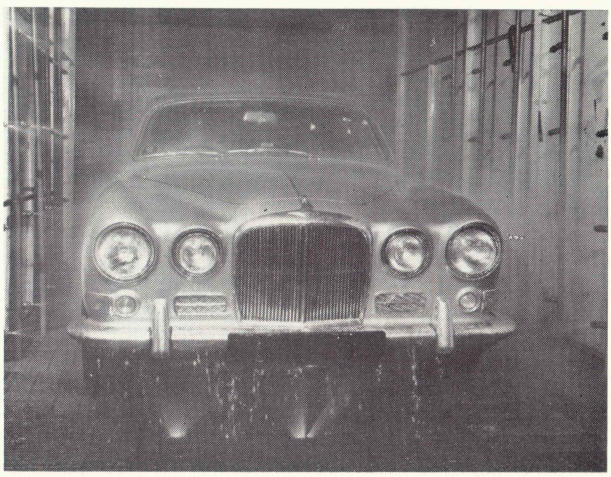
Engine and Gearbox Components

All crankshafts are 'crack detected' for defects and are statically and dynamically balanced. Bearing surfaces are hand lapped to provide a perfect finish. Pistons are X-ray checked and graded for diameter, and sets of six assembled of identical measurements. Each bore in the cylinder block is measured to enable exactly the correct piston to be fitted, thus eliminating minute variations in bore diameters. Connecting rods are also selected by weight and centre to centre length (big end to small end). Big end bolts are an interference fit in the rods, and gudeon pins are a 'push fit' at room temperature in the little end bearing. The maximum weight tolerance on pistons and connecting rods is 5 drams, and the maximum tolerance on centre length is 1/10,000 ins. In addition, crankshafts/clutch/flywheel assemblies are also check-balanced before installation in an engine. Gearbox components are 'crack detected', and gearwheel clusters assembled on a selective assembly basis.

Steering and Suspension Units

Every stressed item in both these assemblies is subjected to stringent tests. Material specification is specially checked before production. Items related to safety—steering box worm and follower, upper and lower suspension ball pins, steering drop and

Every car is road tested on at least two occasions, each one by a different driver, who makes any fine tuning adjustments that are necessary.



Completed cars are checked for water leaks in a special booth where nozzles direct water at the car from every direction.

idle lever arms, stub axles etc., are individually 'X-ray' tested.

Brakes

Disc brake assemblies are tested for hydraulic leaks. Master cylinders and servos are also treated in the same way. Batch checking of hydraulic hoses is carried out in the laboratory.

Testing

Every engine—gearbox assembly is tested for six hours before installation in the car. The first 3 hours are spent at 1,500 r.p.m. to settle the components. They then run for another 3 hours on dynamometers at various speeds and loads, finishing with a power output check. During the whole of this period fresh, clean oil is circulated through the engines from a central supply.

Bodies

These are individually checked for panel finish prior to zinc phosphate rustproofing in a very modern 13 stage plant. The bodies are then passed through a vat of anti-corrosion paint to provide additional protection to the lower panels of the body. They then proceed through a multi-stage paint shop which utilises oven dried synthetic enamel paints. To ensure the highest standard of finish the final coat of paint is only applied after all assembly and testing has been completed (see "car finishing").

Car Assembly

The greatest care is exercised during car assembly for, ultimately, the final standard of the product depends on this factor. The tracks are labour loaded and operated at a speed which provides ample time for the operations to be completed correctly and without haste. A considerable amount of individual hand fitting is employed to ensure a top class finish. There are major inspection stages at the end of each main assembly sequence and, in addition, teams of roving inspectors carry out continuous spot checks throughout the assembly process.

Car Testing

Every car is individually tested at least twice before final painting. The car is taken from the assembly division and put through a road test driven by one of 35 testers specialising in this work. From the tester's report mechanics rectify any defects, make any adjustments, and the car is then re-tested by a different driver. Any additional work is carried out and, only when passed by the Test Department, does the car proceed to the finishing section.

Car Finishing

The car first undergoes a minute inspection of paint, chrome and interior trim. The bodies are then masked and rubbed down in preparation for the final coat of paint, which is hand sprayed, and then dried in low temperature ovens. There follows a second detailed examination of paint finish before the chrome trim, bumpers etc., are fitted and the car finished off. This is an extremely costly process but only by these means can a top class paint finish be produced.

Finally the cars are polished, oil levels checked, headlamps adjusted and the equipment added—spare wheel, tools etc.

Car Protection

To ensure that the car arrives at its point of sale in the condition it left the factory, the exterior is sprayed with a lanolin wax coat covering paint, chrome etc. The interiors have plastic covers on the seats and the floors are covered with thick paper.

Car Despatch

Special arrangements are made to ensure that the cars spend the minimum amount of time in transit. They are stored in the factory premises until required for despatch.

Selective assembly of gearbox components, followed by a test in a sound-proof booth, ensures that the unit is to a high standard.

Connecting rods are checked for end to end balance with a tolerance of only 5 drams. Also centre to centre length is checked with a tolerance of 1/10,000 *in.*

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