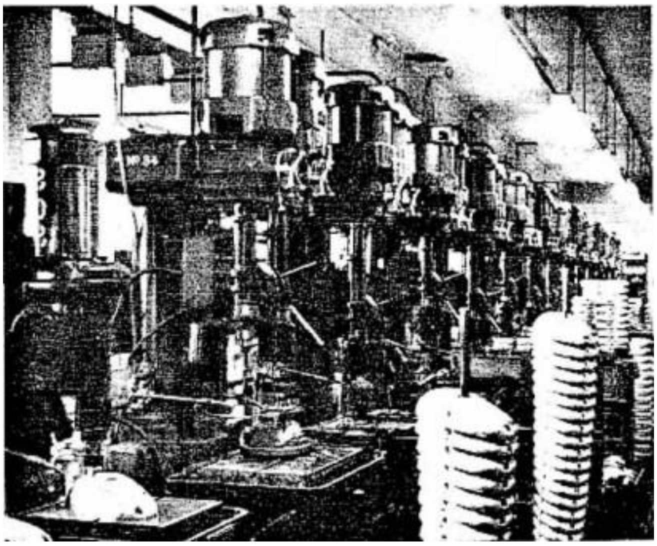
This article is a reconstruction of an extensive observation of the manufacturing processes employed at AMC's Plumstead Road factory, carried out by the Dutch Motor magazine and published as a four-part series in 1962.

The original copies of these magazines were unearthed by our long-time correspondent/researcher Jos Vanderwoude who then, at the risk of developing square eyes, undertook to retype up the whole of the text, so that it could be submitted to Google Translate for conversion into English (even Jos was not able to translate it himself as English has been the recognised language of the Netherlands for most of his own lifetime).

This is How Your AJS & Matchless is Made (Part 1)

Not a quick tour of a factory, but an accurate study in words and images of the production methods used in one of England's largest motorcycle factories, this is what we want to bring in this new series of articles.

Supplemented with drawings and details that may be of importance to the craftsmen, but not in such a way that it would become too dry for the interested layman, as he too sees his own motorcycle emerge step by step.



Associated Motor Cycles

It is generally known that Matchless and AJS are part of a larger group, usually simply referred to as AMC, being the initial letters of the English words Associated Motor Cycles, the mother factory being the Matchless bicycle factory dating from 1878, which started with motorcycles in 1900 and, after the merger with AJS in 1931, continued under the name AMC, but maintaining the original names on the petrol tanks.

Then James and Francis Barnett joined the group and finally Norton. The production of the last factory was not affected by the merger for the time being, but the arrival of the two small manufacturers of two-stroke motorcycles, who had always sourced their power units from Villiers, necessitated a drastic overhaul of the production equipment.

Firstly, because, during the difficult years of the war, the machinery had been used to the limit of production capacity and was in urgent need of renewal, and secondly, because they wanted to take up the production of the two-stroke engines themselves and immediately make important changes to the four-stroke machines and gearboxes.

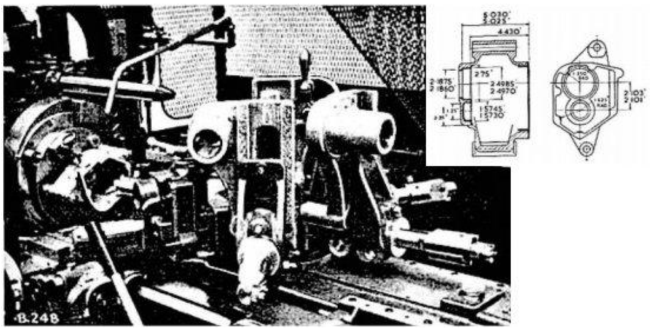
For the renewal of the machinery, one of England's leading specialists in this field, Albert Herbert Ltd in Coventry, was contacted. Engineers from AMC and Herbert designed an entirely new plan for the layout and equipment of the plant, assuming a target production capacity of 400 engine units and 650 gearboxes per week. Almost a million pounds was invested and, in the years 1953 to 1958, Herbert delivered almost 500 new machine tools to AMC, the vast majority of which were installed in the parent factory in the London district of Woolwich, on the well-known Plumstead Road.

Including no less than 150 Herbert turret lathes and 230 drilling machines of various sizes, numerous automatic lathes, horizontal and vertical milling machines, threading machines, etc. etc. etc. But also numerous attachments for clamping the various engine parts. When purchasing this equipment, it was assumed that the machines had to be as suitable as possible for general operations, and this was particularly useful at a time when the production capacity was not fully utilized, because work for third parties can be done without much effort to carry out.

Furthermore, the arrangement of the machines in the factory departments was chosen in such a way that the machined parts needed to be transported internally as little as possible during their various stages of processing.

Machining the gearbox

The machining of gearbox shell is done on a turret lathe. The lugs have previously been drilled into the aluminium castings and the fitting edges milled. An attachment is clamped into the chuck, which can be placed in two positions and is provided with two studs. The gearbox with its lugs is slid and secured on these studs.



The order of the operation is then;

a. Face the flat side of the house.

b. The same rough turning of the bores with diameters 2.1875" and 2.4985. These dimensions can be found in the left drawing, together with the tolerance. In addition to these two operations, a third is performed simultaneously, namely the removal of excessively large projections on the thickenings on the inside of the gearbox shell, where the bolts of the cover have to be screwed in afterwards. This can be clearly seen in the right drawing and indicated with radius 1.250"

c. Simultaneously smoothing the edges of the holes just made, 2.1875 and 2.4985" respectively

d. Turning the bottom "b" advanced holes to size with a microboring tool.

e. Rotate the workpiece with attachment half a turn on the attachment part mounted in the chuck. This brings the gearbox shell onto the lathe in such a way that the hole for the auxiliary shaft of the gearbox now lies exactly on the centre-line of the box.

f. Simultaneously turning the 0.125" diameter blind hole, finishing the bottom thereof and smoothing the leading edge of this 2.225" diameter hole.

g. Simultaneously rough the hole 1.5745" diameter, removing the sharp edge and removing the inward projections from the housing on this side, with a radius of 1.625" (see left drawing)

h. Turning the hole to size 1.5745" The lathe rotates at a speed of 621 revolutions per minute and the support is moved automatically or manually at a speed of one inch per 180 (rough turning) or 240 (measurement) revolutions. All these operations, together with placing the workpiece on the lathe and removing it, should be completed in 6 minutes.

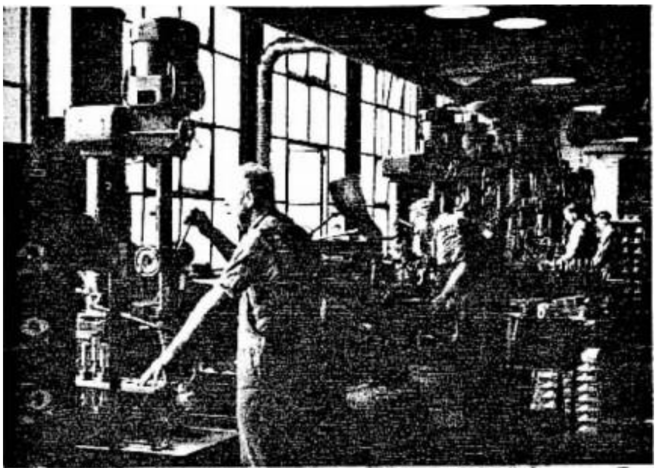
The arrangement of the machines

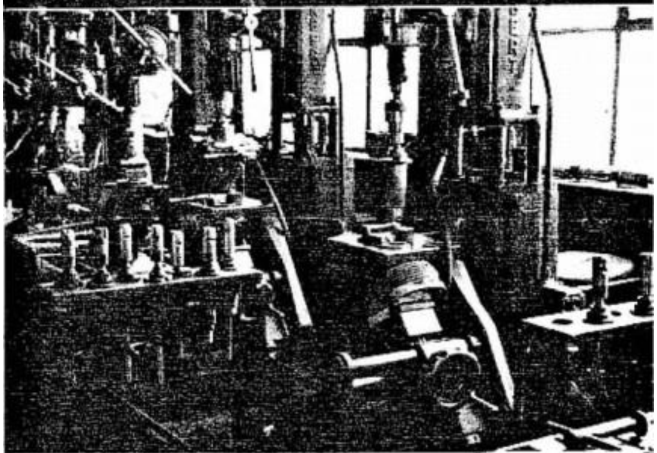
In the foregoing, as well as in the following cases, the order of the work is not so much determined by the need to carry out a certain operation before the next would be possible, but by the desire to use the workpiece for as many different operations as possible, in a certain clamped position on the same machine. As for the drilling machine, this system entails the need to be able to change drilling tools extremely quickly.

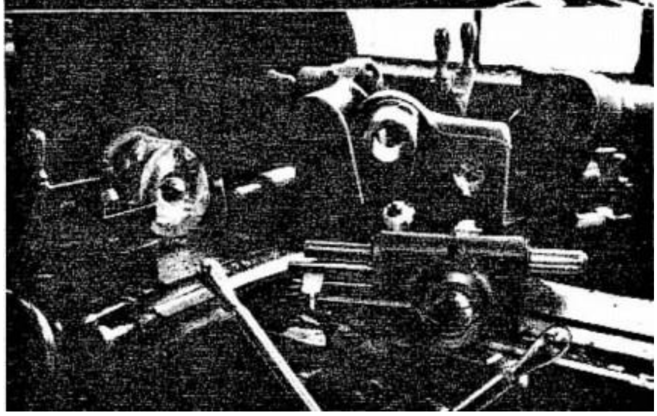
In the redesign of the production equipment, great strides have been made in implementing this system and Herbert argues that in this way a normal single drill can in fact do the work of multiple drills. The drill, the tool to countersink a hole or to form the channels, the reamer, the facing tool, everything can be changed with one hand, without having to stop the machine, without the need for a wrench or other tool and without endangering the safety of the operating personnel!

Some tools required special guidance. With all tools, a guide bush is used in the fixture in which, for example, the cylinder head is held during this operation.

The cylinder head







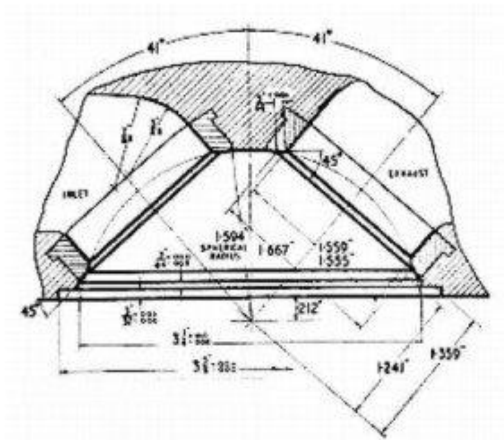
For reworking the cylinder head of the single-cylinder machines, 11 Herbert drilling machines and a turret lathe of the same make are lined up for continuous production. The sequence of operations is as follows.

1. Facing the valve seat.

2. Facing the underside of the cylinder head.

3. Drilling 18 holes ranging from 1/16" to 7/8", tapping 4 holes, reaming 2 holes and countersinking one hole.

4. (at the bottom of the three illustrations) The bottom of the head is machined according to the drawing. After that, the spherical combustion chamber is first roughed-out and then accurately machined with a radius of 1.594".



For this purpose, the cutting tool is mounted in rotatable jaws operated by an arm in the square part of the support. This arm is automatically moved transversely to the direction of support during the processing and when the support returns, it is returned to its original position by a spring. Then the turret is rotated and the bore for the piston (only about 1mm in the head as well as the chamfer (45 degrees) above it is made.

5. Two 13/32" bolt holes are accurately drilled.

6. (Middle illustration) The valve guide shape is machined into the inlet port. Then 4 holes of 19/32" in diameter are drilled and the inlet port takes on its initial slightly conical and later curved course, as shown in the drawing. The outlet duct is then formed. The holes for the valve guides are drilled and then reamed, after which the valve seats get their penultimate turn.

7. Thread is tapped into 9 5/16" drill holes and the push rod holes are countersunk.

8. Finishing the valve guide holes.

9. Drill the holes for the valve spring seat centre pins.

10. Drilling the oil channel to the inlet guide. 1/8" diameter and 4 3/8" long. Drill this hole on the side of the headstock to a 1/2" depth.

11. At the top of the head, the oil channel for the exhaust guide is drilled.

12. The flange for the connection of the carburettor is milled.

13. Next, the intake port is enlarged to 1 3/16 inch diameter and, next to it, the two holes are drilled and tapped for the studs to which the carburettor is to be mounted.

14. The spark plug hole is drilled, faced, countersunk and threaded.

15. The exhaust port is sized and faced.

This is How Your AJS & Matchless is Made (Part 2)

After viewing the machining of a gearbox and cylinder head of a single cylinder last week in a way that almost never allowed by a motorcycle factory, we would like to take you further along the various machines in the London factory. Last year we read of plans to move the entire factory to Sheerness in the estuary of the River Thames. The problem is that the London council authorities have earmarked the entire Woolwich area as housing. Sooner or later, A.J.S. and Matchless had to leave there and after researching the local labour potential, the choice fell on Sheerness. But no sooner had the decision been made than it turned out that a big shipyard had come up with the same idea and this company in nearby Chatham sucked all the workers off the island, leaving nothing for Associated Motorcycles.

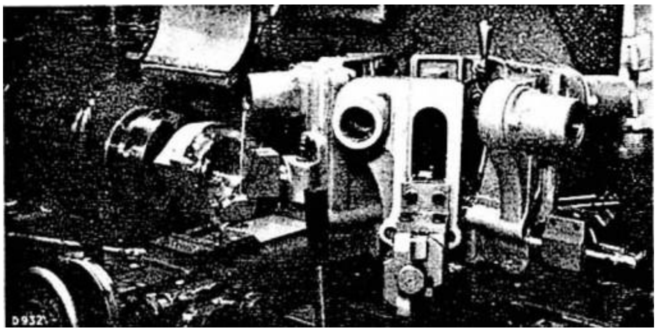
Because although an important part of the old staff from London would of course come along, a factory employing 1,300 men also needs a large local workforce.

The 1300 men is the top line-up. At the time of our visit the number of employees was around 1200 and only a small part of them were involved in the processing and manufacturing of products for other factories such as the automotive and aircraft industries. And this number will have to increase dramatically once Norton is completely gone from Birmingham. At the time of our visit, in early October, there was already a single Norton here and there in the assembly department, but this was probably only to investigate to what extent all three brands can use the same assembly line. Norton's big move will have to be completed around the turn of the year and the reorganization at A.J.S. and Matchless to make room for the Norton production was just in full swing.

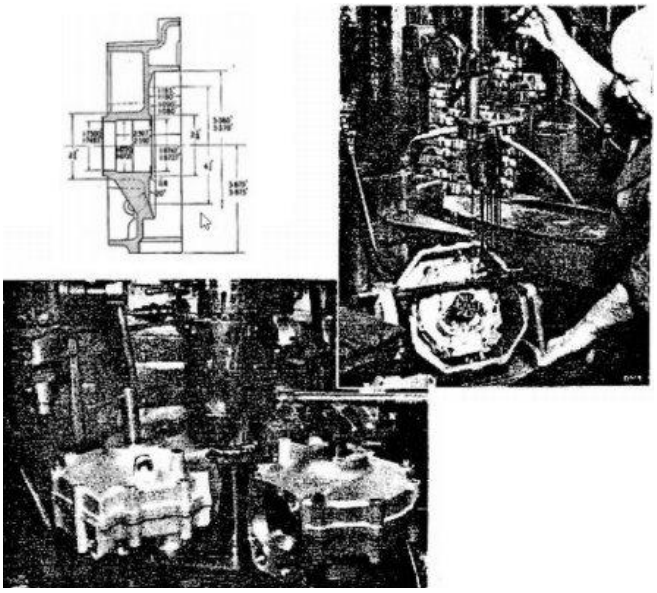
In most British factories we find an agglomeration of all kinds of buildings and buildings that have arisen side by side over time. But the whole A.M.C. concern is, as far as the London department is concerned, in one large building of many floors. Only the race department and the service department are located separately on a small street at the back of the main building. The machines we discussed in the first article are located in the main hall on the ground floor of this main building and will remain there for some time to come.

Machining the crankcase halves

On a capstan lathe, all six tool holders of the turret are fully occupied.



The crankcase part is clamped to the chuck with pneumatic equipment around the 2 3/8" hub side. In the first position of the turret, the inside of the crankcase is bored to a diameter of 2 3/16" (see drawing). At the same time, the crankcase to flywheel diameter is roughly bored to the diameter of 5.380/5.730" and immediately the lead-in chamfer is cut under at an angle of 20 degrees to the vertical. The turret is turned to advance the 1.7500/1.8720" diameter GT and slightly chamfer the crankcase opening. At the same time, tools mounted in the rear tool holder ensure that the sealing edge of these crankcase halves is accurately machined.
When the head is turned to its third position, a new cutting tool ensures that the hole with diameter 1.7500/1.7485" is turned exactly to size and cutters apply the chamfer indicated in the drawing as 1.8742/1.8727". In fourth and sixth position of In the head, the hole 1.8720/1.8705", the chamfer 1.8742/5.370" and the flywheel opening (5.380/5.370") are precisely finished. Time of all these operations plus clamping and removal of the workpiece: exactly 8 minutes.
The corresponding cycle time for the crankcase halves of the twin engines is 7 minutes.



After both crankcase halves are ready, they are put together with four bolts in order to mill the mounting for the machines that still use a separate dynamo. The photo in question clearly shows how the crankcases are secured to the work table and between the two crankcases we see the guide for the cutter. About 3/32" of aluminium is removed from both crankcases at the same time, in a time of 1 minute and 33 seconds.

A nice example of the extensive tooling required before production can begin is our illustration of drilling the oil ducts into a right crankcase half.

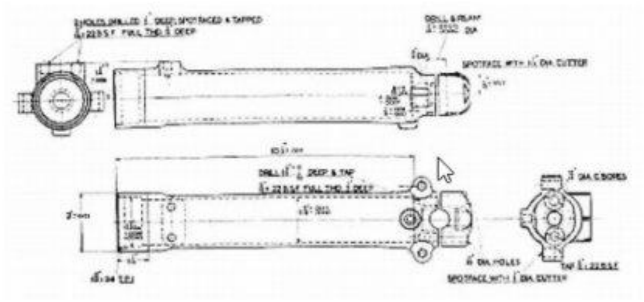
These channels have a diameter of 1/8". The drill length had to be so great that not only immediately above the workpiece we see the drill passing through a guide plate, which is attached to the mounting block for the crankcase, but also halfway through a plate, which is attached to the drill. Tightened into the single-handle crankcase mounting block so that the holes align with the correct angle in the crankcase, At AMC, they themselves have developed a special drilling depth gauge for such cases. Drilling four of these channels takes only 3.5 minutes, thanks to this auxiliary equipment.

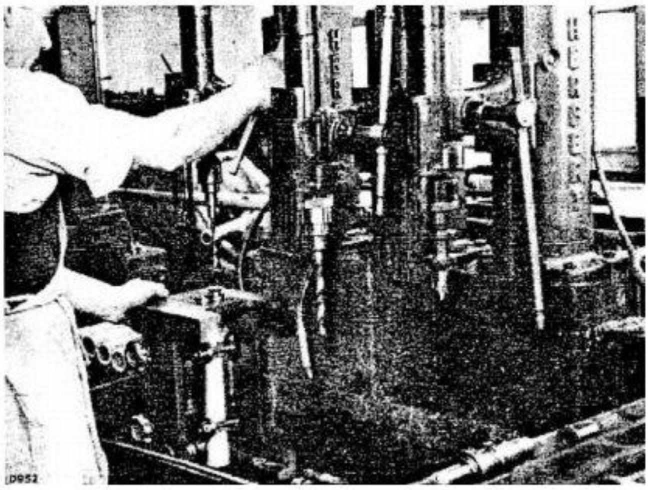
If the quality of this photo after printing is still as we hoped, it can be seen that the crankcase is in a shape reminiscent of an inverted slightly larger crankcase half and that it is rotatably arranged in the mounting block, so that the crankcase can be placed under the drill in different positions by means of a hand-operated mechanism. We think it would be a good idea to consider what, for example, just for such a relatively small operation of new tools would have to be made, if it were decided to introduce a new model of engine. And the smaller the production runs, the more expensive, of course, frequent model changes become

This is How Your AJS & Matchless is Made (Part 3)

The front fork slider

The front fork sliders are first machined on a simple turret lathe. Over a length 0f 1 1/16", the outer circumference is turned down until a 2" diameter is reached. The inside is brought to a diameter of 1 ¾" for slightly less than the length of the part just turned down and a thread is tapped into it.

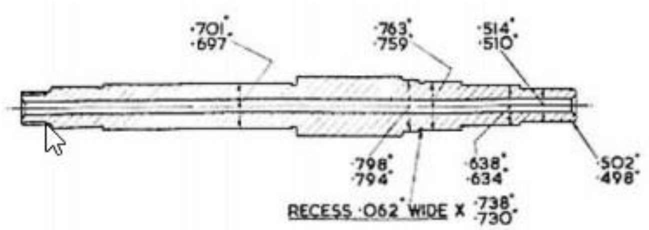




In addition, the entire slider is brought to a 1 9/16" diameter over a length of more than 10". The slider is first pre-rotated, then accurately turned and then the reamer goes through. In these three operations, the turret remains in the same position and the tool must therefore be able to be changed quickly. A laborious stage and the entire cycle takes no less than 11 minutes.
And we're not there yet, because then the slider is then clamped in a workpiece holder, which can be moved back and forth under a three-spindle drilling machine and fixed in all possible positions. In the drawing we see several of the holes that are drilled, countersunk, tapped and/or reamed in this arrangement, or whose perimeter is faced. The tools can be changed quickly on two of the three spindles. The workpiece holder contains four guide holes for the tool. Thanks to the possibility of quick tool changes, all these operations take only 6 minutes.

Gearbox Shaft

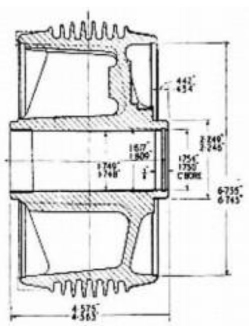
As an example of the machining of gearbox shafts, we will take the main shaft. The material come into the factory as 1-inch diameter rods. First, on a lathe, nearly half of the shaft is turned down to 0.701" diameter and the shaft is also drilled halfway through (13/64"). What we see here is the machining on a second lathe. The shaft is then clamped into the chuck with the part already turned off and the operations involve turning the shaft to no less than five different diameters, applying some 0.062" wide grooves, centring and drilling the rest of the shaft.

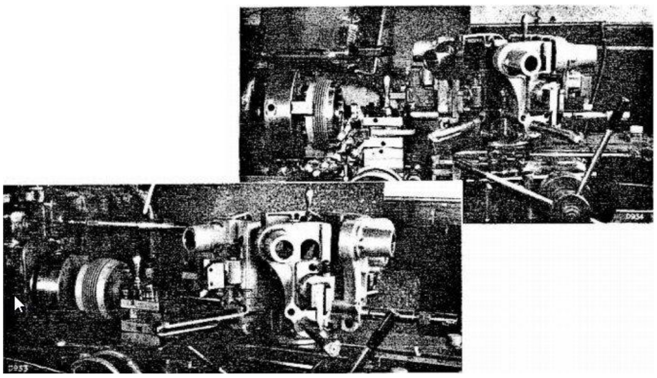


The shaft is clamped to the shoulder of the original diameter. The 0.638" and 0.763" diameters are turned simultaneously, at a rate of 695 rpm. After drilling the 13/64" centre hole, the shaft is supported in the lathe by means of a rotating centre point. This drilling is done over a length of 4 3/8", at a speed of 930 rpm. And manual feed. For the other operations, the feed of the support is automatic. Duration 4 ½ minutes.

Machining the brake drums

It does not seem improbable to us that, in the future, more and more motorcycle manufacturers will source their brakes from specialized factories. But the big concerns, like AMC, will continue to make their own brakes for a long time to come. Aluminium casting is not done at AJS and Matchless itself, but two turret lathes are in constant operation to machine all the incoming raw drums with their cast-iron liners.

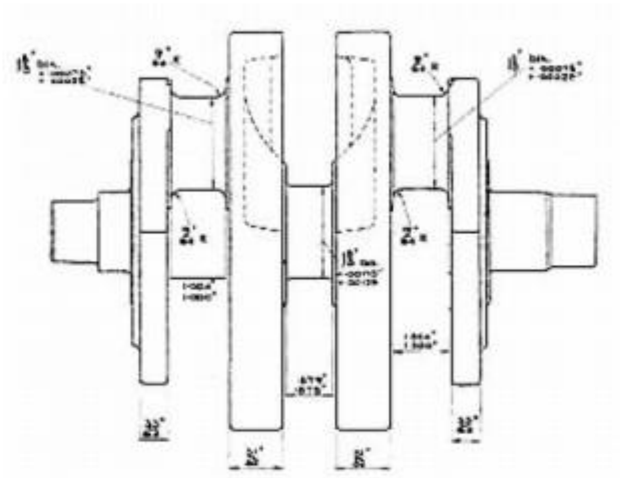


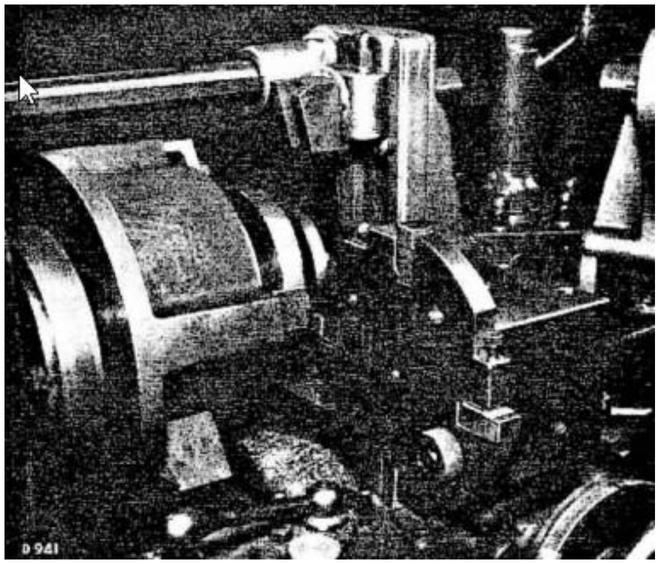


On the first lathe, the drum is clamped with the square side facing the tool. This side is machined and then used for clamping on the second lathe. The thick black lines in the drawing indicate which operations the drum undergoes. The support is additionally guided above the workpiece, but additional support is also found in the shaft hole of the drum when machining the outer circumference of the drum. All these operations take 10 minutes in total. Only after a hub has been mounted in a wheel does the final processing take place, in order to have the greatest possible certainty that no deformations have taken place.

The twin-cylinder crankshaft

Relatively little of the crankshaft can be seen on the lathe, but the drawing is all the more clear and we immediately notice it for the centre bearing, typical of A.J.S and Matchless twin. At the front of the support is a special tool holder with four different cutting tools, which are transverse to the direction of rotation of the lathe.





A special fixture is clamped on the chuck of the lathe, in which the crankshaft can be clamped in two positions, in such a way that either the main bearing shafts or the crank pins are on the centreline of the lathe. In the latter case. one of the crank pins is brought to a diameter of 1 5/8" and a radius to the crank web of 9/64" is formed, while the crank webs are machined on the inside. For the other crankpin, the crankshaft is removed from the fixture and reattached in reverse position. To bring the shaft for the centre bearing to 1 5/8" diameter, the crankshaft is repositioned in the fixture to place it on the centreline of the lathe and the outer end is supported by means of a rotating centre point. At the same time, the middle crank cheeks on the inside are also machined.

Finally, in the next article we will tour the assembly department and competition area of the AMC group in London.

This is How Your AJS & Matchless is Made (Part 4)

With finally a visit to the competition department

Heat Treatment Department

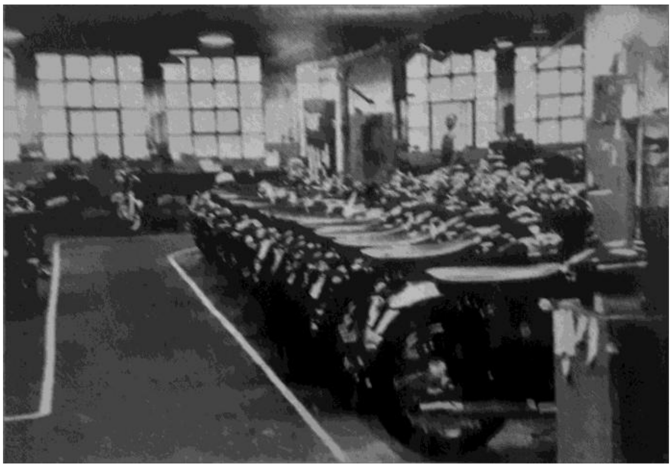
We have lingered long enough between the machine tools on the two lower floors of the large AMC complex and we want to conclude the tour of the London factory with the assembly department. But first, a little sidestep on the ground floor to the unusually large department for hardening all kinds of parts for a factory of this size. There are ten large gas ovens in a row. Where the smaller objects are pushed into bins. Here they are heat treated at temperatures of 900 to 910 degrees Celsius. But the pride of the company is a very modern, enormous carbo-nitriding installation in which it parts are hearted at temperatures from 820 to 850 degrees. These lower temperatures reduce the risk of deformation of the parts to be hardened.

Tube Department

On the way to the paint shop we also pass the "tube department". Here all frame tubes are cut to size, bent and welded, but, although an excellent quality product is undoubtedly obtained according to the methods followed here, we believe that it is precisely this department where more modern methods could be used to produce more rationally. Exhaust pipes are also bent here.

Finishing Department

From there the frames go to the finishing shop, where they are painted, like all other parts, of course after being degreased and treated with phosphoric acid solutions. This bonderizing forms the first layer. Painted parts are first bonded and then dipped in an enamel paint bath. Then black painted parts are passed through a gas oven in which a constant temperature of 200 degrees Celsius is maintained. If coloured enamel is used, the temperature is set at 145 degrees. The transit time is 1 hour and 20 minutes and all parts are painted twice. Next to it was a spare oven to take over in case of failure.



Assembly Shop

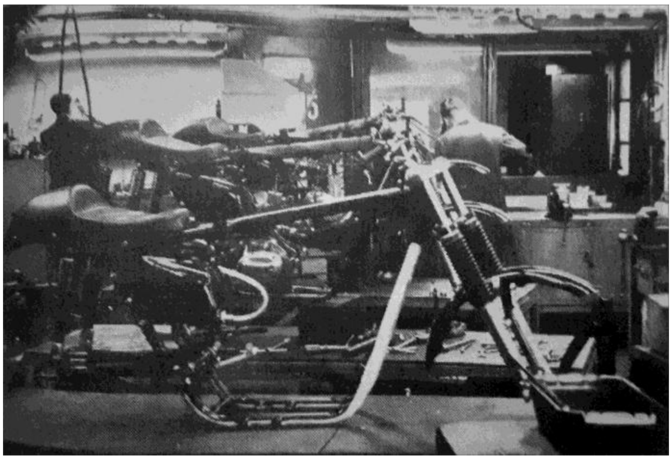
All parts, gearboxes and engine blocks are stored on the highest floor to be transported directly to the various stages of the assembly line. The same line is used for all models. Coincidentally, we also saw a Norton ES 2 in a corner, for the time being still like a stranger at the party, and we were told that they were indeed busy figuring out the assembly options for the Nortons on the same line.
The frames come from the upper floor and are laid on their side to facilitate the assembly of the engine unit and gearbox. Then the frame is fixed on a kind of cart that can be moved along a pair of rails, which run through the assemble shop in the shape of the letter U.
In the first phase, the complete rear frame with the oil tank already present in it is mounted. The cart is pushed by hand to the next mechanic, who attaches the rear mudguard, suspension arm and spring units for the rear suspension. Another step further are fitted the footrests and various smaller parts. The man who attaches the complete front forks to the steering head is exactly at the first bend of the U. Then the front mudguard and the front wheel.
During the next phase, it is the turn of the rear wheel and the chain and chain guard (possibly case) to be attached. Through the next bend of the U, the exhaust pipe fitting man is waiting, who can do it whilst sitting down with the single cylinders and has time to put the handle bars, the levers and cables in place.
He moves the cart to the man who installs the entire electrical wiring, insofar as, of course, not already part of the engine unit.

Here we have come to the end of the U. But the tank and the twin seat still have to be mounted and this is done on a small cross rail on the leg of the U. Of course there are still smaller components attached to the machine here and there. But this is different for each type. Exactly 45 minutes elapse between the arrival of the bare frame and the moment that the complete machine is ready for use from the trolley. However, under no circumstances were we told how many machines could be assembled here per day, but if we had to make a rough estimate, we believe that, given the space available and the tools used, even with more workers than at the time of our tour, it could never be more than about 100 per eight-hour working day. We assume 5 minutes per stage, which should be possible with intensive occupation and..... No tea breaks!

Road Testing

The machines are lined up, after which the test riders come to collect them and take them down to road level by elevator. After the ride they write their findings on the twin seats with a chalk and we saw a few with "shifts heavy", "leaks oil". These machines then go back unless there are small faults that the tester can immediately remedy, such as a carburetion that is not entirely in order. Each machine is tested over a ride of approximately 5 miles.

Finally a visit to the Race Shop



The race shop area is strictly separated from the mud and sand competition motorcycles. The difference was very striking. Not that there were chaotic or filthy conditions in the large workshop where dozens of cross-country and trials machines were being worked on simultaneously. There wasn't even a clump of mud on the ground, but it was still nothing compared to the painful brightness in the racing department. Besides, in the latter department, not only were the machines prepared for the own riders and repair customers, but also here the 7R Boy-racers put together for the future customers. Yes, only boy racers, because the Matchless G50, the 500cc version of the AJS, has unfortunately been taken out of production. Something to which the closer association with Norton will not be strange.
We got there about 4:30 pm, but at 7:30 pm we were still there, talking to the race department chief, Mr Williams about the sport and technology, which are so dear to our hearts and he didn't want to know about going home. What a paradise for the enthusiast!
The AJS 7R may be a conventional racer, compared with Italian or Japanese stuff, but its development is certainly not the clumsy work that the English manufacturers are sometimes accused of. The two test benches are in separate cellars and the engines are tested with their own megaphones. The gases are therefore not discharged through pipes, but are released into space.

In front of the engine, however, a huge fan has been installed, and, behind the test stand, is a generously sized exhaust grille. The gases are thus taken along, the engine is cooled and ...... the effect on the extent to which the gases are removed from the megaphone is equal to the conditions at a driving speed of approximately 160 km/h.
Anyone who remembers our article on "jet cooling" will be interested that it was indeed concluded at AJS that it was important for the purity of the experiments carried out on this test bench to have air pass through the exhaust opening. at a speed corresponding to normal racing conditions. Although the difference was not great, it was nevertheless easily measurable. In fact, several experiments concerning the shape of the megaphone were carried out especially with a view to this effect. Also the location from the mouth of the megaphone had been a point of investigation, namely more or less outside the streamline wind shadow, without it causing too much air resistance in practice.

Two tachometers were used in all tests. One in the normal way from the engine, the other from the water dynamometer used as a brake. This is to be able to quickly identify any meter deviations. The most rewarding part of the four-stroke engine when revving up is the cylinder head. A special test table had therefore been developed to investigate the correct course of the ports in the heads. The head is mounted on a cylinder, which is placed on the table. The outlet side is plugged and very fine holes are drilled in the wall of the inlet port, which connect to very small diaphragms. These are each provided with a coil and the currents generated therein are passed on to an oscilloscope, so that the pressure variations in the experimental inlet ports can be read on the cathode ray tube.

This pressure is produced by a precisely calibrated amount of air being introduced into the inlet line and exiting the cylinder at the bottom. From here it is only one step further to measure the course of the pressure waves when a piston is moved up and down in the cylinder and when the valves are operated in the normal way at the same time. The results obtained in this way were so interesting that, since then, this installation has been used not only for racing motorcycles, but also for devising new cylinder heads for all touring machines of the brand. It is sometimes claimed that racing is of no use, but this is how one sees how racing technology is put to good use for touring machines.

One day, the owner of the famous BRM racing cars knocked on the door of AJS. He had heard of the test equipment and came to ask if the race shop would also examine the cylinder heads of his engines for him.

In the other corner of the large basement, we spotted a homemade device for examining suspension elements with shock absorbers. A number of years ago, both road racers and motocross machines had serious difficulties with shock absorbers, both with their own manufacture and with those purchased from special factories. So a special device was made.

The principle is nothing startling, namely a floating arm with wheel that is moved up and down by a large wooden cam. Other cam wheels with more and differently shaped cams can also be mounted and the machine can rotate at any desired speed according to practice. The shock absorber is attached to the suspension arm with its lower eyelet and the upper eye is attached to a second suspension arm, which can be loaded with any desired weight, which as a rule will correspond to the part of the machine plus rider weight, which normally rests on the rear wheel. On both the upper and the lower floating arm are small pens that work on graph paper, which is stretched on rotating drums. The tester can therefore easily read to what extent the bottom line follows the pattern of the ridge as much as possible, and the top line remains horizontal as much as possible. By varying the springs, type of oil and damping, he can approach this ideal as much as possible and it goes without saying that this device has also earned its money for a long time, also for touring machines.

Incidentally, the frankness with which we were told about and demonstrated this did not extend to all the equipment present in this laboratory, and when we rested our gaze on a particular cylinder head for an unusually long time, to which, in addition to the normal inlet duct, we found a second inlet duct in an unusual place, that 7R head was quickly put away, with a thousand excuses.

So while there are signs of a contraction in racing activities at the AMC factory, on the other hand, the development work does not stand still. If the sales of ordinary motorcycles do not improve, the racing department will inevitably also have to be curtailed, but perhaps the solution lies in working very closely with the men from the Norton department?

As far as motocross is concerned, people were optimistic.
After Dave Curtiss. there was no good factory rider, but they have now recruited three very promising young guys and especially Vic Eastwood. They want to get a Grand Prix experience with the 500 cc machine this year. The fact that Bickers came up with a Matchless also proves that the factory definitely wants to do something for off-road sports. It is also a good incentive that the Rickmans have chosen the Matchless single-cylinder as the power source for their latest Mettisse. In short, there is still life in the brewery at the only large English factory, which supports road racing, motocross, trial and reliability rides!

Notes:

1/ Parts one to three of this series of articles predominantly comprise information (machine operation lists, component detail drawings and photographs) that was previously published by Alfred Herbert Ltd, following their re-equipment of several of AMC's machine shops.
Full details of their involvement can be found in the AH article accessible from the Links page.

2/ Departmental headings have been added to Part four in order to more easily identify the different sections of the AMC factory being discussed.