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# MARINE CRANKPIN AND SHAFT RECTIFYING AND POLISHING IN PLACE, WITHOUT THE DISMANTLING OF THE SHAFT, WITH A PORTABLE DEVICE

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ABSTRACT

The subject of the present abstract is a compact, portable device for marine crankpin and shaft rectifying and polishing IN PLACE, WITHOUT THE DISMANTLING OF THE SHAFT.

Whenever a marine (ship or offshore) crankpin or shaft gets ovalised, corroded or scored, accurate rectification is absolutely necessary and this presents very serious problems to the owner.

The traditional methods (dismantling the shaft and machining it in a lathe, or executing the work in place BY HAND) are rejectable for various reasons: these methods involve enormous losses of time, money and manpower, and/or the accuracy is not at all guaranteed.

The device developed by our company is mounted around the shaft, in place. The results are guaranteed to be comfortably within the Classification Organisations' requirements (parallelism and diameter are within a tolerance of 0,02/0,03 mm. for the smallest diameters till 0,05 mm. for the largest diameters).

Time and costs are, on average, about 1/5 for the smallest sizes till 1/20 for the largest sizes, compared to the dismantling of the shaft and doing the rectification in the lathe.

The machines are easily portable and transportable and this work can thus this work is being executed all over the world.

## MARINE SHAFT RECTIFYING IN SITU, WITH A PORTABLE DEVICE

(Longueville Gebrs. P.V.B.A., Antwerp, Belgium)

Any damage (grooves, ovalisation, corrosion, etc.) caused to large marine crankshafts and other shafts which are difficult to dismantle, means a real nightmare to the owners. The shaft must be reconditioned again as soon as possible. Each hour of idle time means a considerable loss.

Formerly, two solutions were possible.
First, one can try and execute the work by hand. Files, emery paper, and sometimes cast iron grinding bushes (driven by pulling ropes) are used.
This method is objectionable for two reasons:
- It takes an awful lot of time and manpower, and
- The accuracy of parallelism and diameter (utterly important) is not at all guaranteed. Very often the work has to be redone mechanically, which brings us to the second traditional solution.
This solution consists in maching the shaft in a suitable lathe.
This sounds simple, but it is evident that it involves quite a lot:
The shaft has to be
- stripped;
- dismantled;

- rigged out of the engine room;
- put on a lorry;
- transported to the nearest machining shop where a suitable lathe is available (in some countries, if not in the most, there is no such lathe; in that case the shaft has to be air transported - if possible - to another destination);
- put into the lathe and machined;
- retransported to the vessel;
- rerigged into the engine room;
- remounted;
- redressed.

For the crankshaft of a small auxiliary engine, in favourable conditions, the whole of the abovementioned activities will take at least one week, working with five or six technicians.
For a large main engine crankshaft, the delay will be six weeks or more, working with ten to fifteen technicians. In some cases a hole has to be made in the ship's side to get the crankshaft out of the engine room.
It goes without saying that the costs of such an average operation are quite considerable, apart from the ship's idle time.

Since several years, devices have been developed to cope with those problems. They had all, however, some technical-commercial drawbacks.
Some of the devices gave results with inadmissible tolerances, scarcely better than the results of the hand working methods.
Other devices (for instance, pure honing methods) took weeks or more for a substantial reduction of the shaft's diameter.
There were devices which transposed the centre line of the shaft away from the main axis, which, of course, is most rejectionable for main journals and propeller shafts, for instance.
Still other machines gave acceptable results, but proved so heavy and voluminous that it was impracticable to transport them by the usual means (car, delivery van, airplane).



Research for an improved system, or rather a combination of improved systems, started four years ago. As a starting point a synopsis of the existing systems with their advantages and drawbacks was made by the designing engineers.
Soon it was clear that it would be unwise to design one system only. Too many factors are involved with the accurate and efficient in situ reconditioning of a marine shaft.
Just to mention the most important ones which determine the system to be used in any particular case:
- The diameter of the shaft;
- The width;
- The amount of metal to be removed;
- The hardness of the shaft;
- The available space around the shaft;
- The required micro-finish.

To drive the machines, three kinds of motors were considered: electric, hydraulic and compressed air motors.
After careful consideration, the electric motor was found to have less output for the same volume; the hydraulic motor, apart from various other disadvantages, did not provide the required speed to drive the special grinding stones efficiently.
So the compressed air motor was selected eventually.
An additional advantage of the air motor is the fact that almost any vessel from two hundred tons displacement upwards has a satisfactory supply of compressed air to feed the motor.
The required pressure is 6-7 kgr/cm2. Approximate consumption is between 0,6 m3/minute (for the smallest machines) till about 5,0 m3/minute (for the largest machines).

It was decided that, for the time being, the diameter size range of shafts to be treated would be restricted from 80 mm. to 1.000 mm.
Below 80 mm., generally it is not too difficult nor costly to dismantle the shaft; above 1.000 mm., the range of shafts in use is rather restricted.

However, in principle there is no technical objection to construct rectifying devices based on the same systems outside the abovementioned range.

Eventually, four systems have been developed. The first two machines described below are used to execute the "rough" work.

Firstly, there is a turning device, machining with a lathe chisel in a special alloy. This machine is used if a considerable amount of metal has to be removed (say over 2,5 mm. in diameter).
The setting and adjusting of this machine on the shaft takes several hours, but once this has been done, the machine removes an important amount of metal in a very short time.
The drive is from outside the crankcase by a shaft, which is moved by a powerful air motor.

Secondly, a grinding machine, equipped with a special grindstone
This machine is brought in when the amount of metal to be removed lays between about 2,5 mm. and 0,10 mm., or when the available space around the shaft is too restricted to use the machining device described above.
The grindstone is driven by a specially adapted air motor.
When selecting this air motor, several features have been taken into account:
1) A speed which corresponds to the prescribed optimum R.P.M. of the grindstone.
2) The required minimum output.
3) The smallest possible volume and weight, without sacrificing anything in quality.

Normally, the operation carried out with one of the two above-mentioned devices is to be followed by the using of one of both following finishing devices.



The third machine is used to give a normal polishing finish to the surface of the rough-treated shaft.
A specially designed iron frame with a wormwheel is built in two halves around the snaft. Inside, there are cast iron polishing bushes (machined to measure), revolving reversible around the shaft. A special grinding paste is added.
An added arrangement makes that the weight of this device is compensated for, in order not to flatten the upper side of the shaft.
This machine is also driven by an air motor.
It is used also when the amount of metal to be removed is less than about 0,10 mm. in diameter.

The fourth device is a superfinishing attachment which is mounted on the frame of the first mentioned machine. A fine grit superfinishing stone, preformed to the radius of the part to be superfinished, is pneumatically pressed against and rotating around the shaft.
During the superfinishing operations, the stone oscillates parallel to the axis of the shaft at a high speed driven by a pneumatic power unit.
A surface finish of 1 micron is obtained without problem.
This machine is used to give a superfinish to turbine shafts, crossheads, etc.

All but the third machine are based on correct fillet radii - the only way to ensure satisfactory results.

The results obtained when using properly the devices described above, show a maximum tolerance of geometrical parallelism and diameter of 0,02/0,03 mm. for the smallest sizes of shafts till 0,05 mm. for the largest sizes.
In this respect it should be noted that manufacturers give a tolerance of 0,04 to 0,05 mm for an average sized new crankshaft.

The leading Classification Societies have given their official approval for these various systems.

Apart from the accuracy and the efficiency of the device, during the design and construction special attention has been given to light weight and small volume, this in view of the skyhigh air transportation costs of today and the ease of handling during the mounting around the shaft.

The applications of the systems in the marine field are numerous.
The following parts can be treated successfully:
Crankshafts, tail end shafts, intermediate shaft bearing surfaces, thrust bearing surfaces, hydraulic rams for steering engines, bearing surfaces of rudder stocks, propeller shafts, compressor and pump shafts, sliprings, D.C. generator collectors, etc.

As mentioned before, an important element in this speciality is the delay.
A shaft with an average diameter, say 250 mm., with grooves or an ovalisation of 1,00 mm. in diameter (which more or less could be considered as an average damage) can be rectified and polished in situ in about 12 to 15 hours.
As the time needed to mount, set and adjust the rectifying devices on the shaft is more or less the same for a small or a large shaft, the reconditioning of a small shaft and/or a minor damage will require proportionally more time, and the reconditioning of a large shaft and/or a severe damage proportionally less time.

Technically, there is no practical limit as to the amount of metal that can be removed with the devices. However, it is advised strongly that the prescriptions of the shaft makers and the vessel's Class Surveyors should be respected.
Most Classification Societies allow that between two per cent and four per cent of the shaft's diameter may be removed.



One word about the technicians who execute the work.
As still is the matter in many operations, the results are very much depending on them. (The best car in the world may be useless and even dangerous in the hands of a bad driver).
These engineers need to be dedicated, well-trained and careful as a surgeon, although in many cases they are executing their work with the knowledge that the ship's Master is (im)patiently waiting till they are finished, and that the Chief Engineer (and probably the Superintendent too) is looking over their shoulders, sometimes with a certain reserve.
These engineers should be able to find solutions for unexpected problems.
Sometimes they arrive on the spot, ten thousand kilometres from their base, at the end of nowhere, to find out that they carry machines with wrong dimensions, because an error has been made by the people who communicated the measures of the shaft or the type of the engine. They must then, mostly with very restricted means, try and adapt the rectifying machines to the real measures of the shaft.
Sometimes the damage has been stated by the Chief Engineer as being around "one millimetre" in diameter whereas the real figure is closer to one centimetre.
Other times, contrary to the Customer's statements, the fillet radius of the shaft is damaged. The engineers then probably yet shall try and execute the work, and although no guarantee can be given in those circumstances, in most of the cases they will succeed in doing a satisfactory job.
They are supposed to meet and solve all these problems, in order to avoid a financial disaster for the Owners.
In doing this, they deserve respect.