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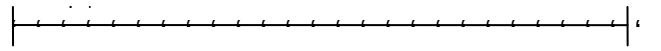
SENSING ON THE B.T.M. HIGH SPEED MACHINES 44

1) It is evident that the sensing apparatus can only work if, for each position of the High speed drums in which sensing is to take place, all the other drums and particularly the F drums are properly positioned. It is assumed here that this condition is satisfied, so that we only have to consider the H.S. drums themselves.

2) Consider first one particular H.S. drum and its commutator. The length of the commutator contacts is about twice the length of the insulation between them - slightly more in the case of the inner ring. The length of each brush face when the drum is on the machine is almost equal to the length of the insulation on the outer ring, which is approx. equal to the length of the contact on the inner ring. Thus as the drum rotates, the brushes of the inner ring are each touching two contacts for about a third of the time, while the time during which the outer brush is not touching a contact is very small.

Consider three positions of the drums :l, m, & n. Consider the interval AA' of 2 milliseconds from halfway between l & m to halfway between m & n, & divide this interval into 25 points.

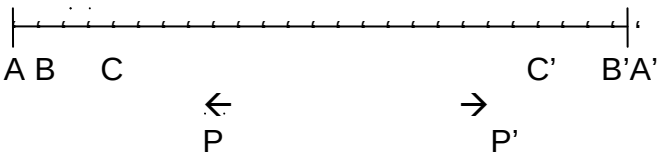


At A the outer ring of the brushes are not touching any contact. About 1 point after A, at B, all brushes have made contact in position m. About 4 points after A, at C, all inner brushes have ceased to make contact in the previous position l.

About 4 points before A', at C', some inner brushes make contact with the following position n.

About 1 point before A', at B', some brushes in the outer ring leave the contacts of position m. Finally at A' the outer ring of brushes are not touching any contacts.

3) When 36 H.S. drums are moving together the position is slightly different. Each drum is always put on the same shaft, and accurate timing reduces the effect of variations between drums. But the difference may amount to about 1 point. Thus the time B at which the last outer brush makes contact in position m, and the time C at which the last inner brush ceases to make contact in position l are both moved further away from A - by about 1 point. Similarly B' & C' are also moved about 1 point further from A'.



4)During the period CC' a pulse will show up a straight. During the periods BC, C'B' a pulse will show up nothing since the shorting of the inner brushes will "fill up" the input. But during the periods AB, B'A' a pulse would find open circuits and would show up a false straight.

First of all it is clear that, if the faces of the outer brushes were longer than the distance between the two outer contacts, the periods AB, B'A' would not exist, and it would

be possible to use a continuous pulse. All that would matter then would be that CC' should be long enough to enable the sensing apparatus to detect a straight.

The brushes and commutators were designed for the 3 - wheel machines, on which mechanical commutators present no difficulty. The brush faces are made as long as possible with the object of reducing the intervals AB, B'A' to a minimum, but a redesign of commutators would be necessary in order to get rid of them altogether. Thus it is necessary to introduce an intermittent pulse of period PP'.

5)The conditions that must be satisfied by the pulse period PP' are,

a) PP' must lie inside BB'

b enough of PP' must lie inside CC' to enable the sensing apparatus to detect a straight.

After a Bombe has been running for some time it is to be expected that the position of the points B, C, P, P', C', B' in the interval AA' will vary. The chief cause of variation in the position of PP' is wear of the pulse control brushes, and this can easily be overcome by changing these brushes at regular intervals. Incidentally this wear will tend to make PP' drift towards A. The chief cause of variation in the positions of B, C, C', B' is damage to drum brushes, which is kept under control by routine inspection of drums.

If the drift of the various intervals is enough to let P get to the left of B or P' to the right of B', open circuits will produce wrong stops and the situation will be revealed.

Incidentally, if P' gets to the right of B', sparking will occur causing damage to commutators. But either P and B or P' and B' can drift together without anything being noticed. At the same time C or C' may have drifted inwards, and there is a danger that too little of the interval PP' will remain inside CC', causing a straight to be missed. It is therefore an advantage to have the pulsing interval PP' as long as is possible without causing PP' to overlap AB or B'A' too easily. It was thought that a pulsing period of about 12½ points would provide the best compromise, and indeed it has proved quite satisfactory. However, the relays only need 6 points inside CC' to detect a straight and experiments are being carried out with a shorter pulsing period.

6) Valve sensing would only require about 3 points inside CC' to detect a straight, but it is hard to see that this would be any great advantage . What slight advantage there might be would certainly not outweigh the disadvantages of changing over to a new type of sensing equipment and losing the unity of the whole design. The relays have a good safety margin and are proving quite satisfactory. In fact the idea of changing over to valve sensing seems quite silly & pointless. It would not remove any serious difficulty. On the other hand a change of commutator design to enable us to use a continuous pulse would be an improvement, as it would cut out the valve pulsing apparatus altogether.

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