IGNITION CONTACTS

INTRODUCTION

The problem of contact breaker design is of an extremely intricate and involved nature. This will be apparent when it is realised that the contacts which make and break the primary circuit of an ignition coil carry about 3 amperes at voltages up to 300, that melting at the point of contact (at temperatures of 3000°C. and above) takes place each time the contacts separate, and that this occurs at a rate up to 320 times per second dependent on engine speed. Much painstaking research work has been undertaken in determining what actually occurs at the contacts during operation of the ignition system, and the results of this study have formed the substance of many interesting technical theses.

Usually, however, because of the complex nature of the problem, the results of such investigations are necessarily couched in technical terms not readily understandable to the average automobile electrician or owner-driver. These notes have therefore been prepared in an endeavour to summarise, as simply as possible, the various factors which have to be borne in mind in the choice of contact materials and the design of the contact breaker and its associated circuit. Further, it will be apparent that in service some discolouration of the contacts and a degree of wear is almost certain to occur, but normally this will in no way affect the functioning of the ignition system.

MELTING, ARCING AND SPARKING

When an inductive circuit is broken, as in the primary circuit of an ignition coil, a rise of voltage occurs across the contacts. Owing to the fact that the actual break takes place at only a single point on the contact face, no matter how large the contact area, the resultant current density at that point is very high. Consequently, the metal in this region on both contacts becomes intensely hot and melts, so that as the contacts separate a little bridge of molten metal is formed between them. Further separation causes this bridge to fracture, but the circuit inductance (which roughly corresponds to inertia in a mechanical system) has the effect of prolonging the current flow through the contacts as they separate. The current will continue to flow through the medium of an arc, the latter being easily established across the hot electrodes. Subsequent cooling of the contacts results in the extinguishing of the arc which is then succeeded by a spark lasting until most of the energy is dissipated.

It will therefore be seen that what appears to the casual observer to be a simple spark at the contacts is actually the sequence of events described. Each of the above effects causes deterioration of the contacts; the molten bridge, because of unequal local heating of the contacts, causes transference of metal from one contact to the other, producing the well-known "pitting and piling" effect; the arc causes burning and oxidation of the contact faces; the spark gives rise to another form of transference of metal, in the opposite direction to that produced by the molten bridge.

REDUCTION OF ARCING AND SPARKING

It is necessary, from the point of view of both contact life and coil performance, to reduce the amount of arcing and sparking. This can be accomplished by connecting a condenser across the contacts, the condenser forming in effect a bypass circuit for some of the current which would otherwise flow through the contacts. (This is actually a secondary function of the condenser, which is necessary in any case to ensure the maximum efficiency from the ignition system.) By suitably varying the capacity of the condenser and the values of resistance and inductance of the subsidiary circuit it is possible to control arcing and sparking, but it is not possible to influence the formation of the molten bridge.

On the other hand, it is not desirable to eliminate arcing and sparking entirely, since this will leave on the contacts the "pit-and-pile" formation which, while in no way affecting the ignition performance, makes setting of the gap more difficult. The constants of the condenser and associated circuit are therefore arranged so that a certain small amount of arcing and sparking is allowed to take place, enabling the material which has been deposited to be removed, and, to a certain extent, transferred back to the contact.

Owing to variations in battery voltages, engine speeds, sparking plug voltages, etc., it is necessary to achieve a compromise, since perfect balance can be obtained only under one set of conditions. The maintenance

of even untarnished contact surfaces depends on the perfect balance of many different factors, and it is not surprising that under normal working conditions this balance is upset, resulting in the transference of metal in one or other direction or a certain amount of oxidation.

CONTACT MATERIALS

All metals which are suitable as contact materials are acted upon in the manner described. Where the current is undirectional, the tendency to transference is naturally increased. It is on this account that tungsten contacts are always employed in coil ignition equipment; other metals, such as platinum and its alloys for example, are superior to tungsten from the standpoint of oxidation, but are very susceptible to transference and are suitable for use only when the current reverses.

CONTACTS IN SERVICE

From the foregoing, it will have been realised that, under normal conditions, some degree of transference and oxidation is to be expected in service and it should not be immediately concluded that this is due to faulty contact material, condenser breakdown or incorrect ignition conditions. Many condensers and contact sets are known to have been replaced unnecessarily because of the appearance of the contacts. Generally speaking, provided that the gap can be adjusted to the correct setting, the ignition contacts can be relied upon to give satisfactory operation for a very long period.

One further point should be borne in mind. Under hot, humid climatic conditions, there is a tendency for a film to form on tungsten contact surfaces; this film must be removed before putting into service contacts which have not been in use for some time.