800-03

PROPOSAL FOR EXTENSION

of

PROJECT ARIEL

for the

British-American Tobacco Co., Ltd
Westminster House, 7 Millbank
London, S.W. 1

BATTELLE MEMORIAL INSTITUTE
International Division
7, route de Drize
Geneva

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- Nucleating the nicotine in a suitable way.

- The use of additives to the tobacco or tobacco extracts in order, firstly, to maximise the amount of nicotine in the aerosol and, secondly, to influence the nicotine absorption in the human body.

For these reasons the research work should be concentrated on two points:

- Investigating the incorporation of agents to maximise the rate of nicotine release and to optimise the physiological absorption of the nicotine aerosol.

- Obtaining the chemical-engineering data for evaluating the performance of the various devices, and determining the optimum design and working conditions for the most promising devices.

Modification of the taste with a view to improving the acceptability of the "smoke" would be deferred until after the technical data required for writing the final application had been obtained.

2. RESEARCH PROGRAMME

To solve the problems mentioned, the research work would be conducted under close co-operation between the Southampton Laboratory of B.-A. T. and Battelle-Geneva, whereby the contributions of the Southampton Laboratory would be along the following lines:

- Technical advice on the preparation of the tobacco and tobacco extracts to be used in the device.

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- Construction of a piece of equipment operated by hand which would insert central tubes into "cigarettes" of various sizes and lengths. This should operate at about 50 "cigarettes" per hour and help to produce consistent experimental material. This is expected to be ready for dispatch to Geneva by the end of March.

- Design of the outside smouldering wrapper for the heat supply to give a heating regime to be defined by Battelle.

The Southampton Laboratory will ultimately be responsible for the economic manufacturing technique of a commercial article. In particular, they will devote attention to the development and construction of central tubes of the types that Battelle-Geneva have found to be satisfactory.

Battelle-Geneva would concentrate its research work on the following points:

- Construction of a simulator in which controllable electric heating replaces the smouldering heat of the outside wrapper of the final device in order to explore in a quantitative way the influence of design data on the performance, such as diameter of the carrier tube, its dimensions and the shape of the nucleating chamber.

  This apparatus will be designed to permit experimentation with different materials for the carrier tube and various fillings, and various additives.

  The procedure expected to be followed is set out in a note of a meeting of Battelle and B.-A.T. scientists which is attached as an Appendix to this proposal.

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- It is recalled that the aim of a final device should be to deliver up to about 2 mg nicotine in 10 puffs of 35 ml at one puff per minute. As the duration of smoking is set at 10 minutes, this will in the final device be determined by the smouldering characteristics of the outside wrapper. The number of puffs taken during this period being independent, investigations would therefore be made on the effect of different frequencies of puffs, possibly of smaller volume, under constant external heating regime.

- The physiological behaviour of the aerosol would be tested on rabbits using the techniques worked out under the MAD HATTER project.

First priority would be given to that particular device which appears most promising, but in this first phase the investigation of each device would not be taken further than is necessary to establish a sound final patent. This phase of the work is to be completed by the end of October 1963. The second phase will be devoted to more detailed investigation of that form of the device which is considered to offer most promise.

The objectives in the second phase will be to use the techniques already developed to make the preferred device produce as closely as possible the best physiological and psychological features of the cigarette. The co-operation and advice of the scientists associated with the MAD HATTER and HIPPO projects will be called on where appropriate.

An important feature of this phase will be to produce an appreciation of what has been achieved, what the further objectives of the research should be, and what further contribution to the achievement of these objectives Battelle-Geneva consider they could make.

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3. DURATION AND COST OF RESEARCH

The research programme outlined above would require twelve months.

According to the rules of the Institute, the expenditure entailed by the proposed research would be charged on a cost-incurred basis. The relevant budget would not exceed the sum of Swiss francs 200,000.-- (£ 16,500.--).

4. START OF WORK

Research work should start, as a continuation of the ARIEL-I project, on 1st March 1963.

Geneva, 7th February 1963
CHH/HS/eb
191-12/191-32

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APPENDIX

SUGGESTED SCHEDULE FOR EXPERIMENTS

PART 1

What follows summarises the discussions held at Southampton on January 22nd to 24th. The points that were dealt with are listed in what seems at this time to be a logical order, and the experiments suggested are numbered in order to make later reference convenient. This is by no means a hard and fast programme as later results may indicate the need for modification of the opinions at present held.

1. Study of extraction procedures.

   i) Tobacco to be ground coarsely.

   ii) Treat in domestic type mixer with cold solvent.

   iii) Test three extraction procedures outlined in letter DGF to Dr Haselbach (preference for extraction probably (c), (b), (a).

   iv) Evaporate and weigh extract and determine nicotine content

   This will determine the optimum nicotine content in terms of the extraction procedure.

2. Choice of additive.

   i) None

   ii) Magnesium trisilicate

   iii) Alumina

   iv) Silica in some form (Aerosil)

   v) Precipitated chalk

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All experiments from now on to be made incorporating thermocouples in the device. Temperature-time (distance) profiles to be reported. Nicotine transfer to be measured after 2, 4, 6, 8 and 10 puffs.

3. Study of effect of additive and choice of extract.

At a fixed number of puffs, heat input, tubes design, tube dimension, tube material, test combinations of 1. and 2. for maximising nicotine transfer. The experiments would be 1 (i) c, b and a vs. 2 (i) at two levels of nicotine applied to the device. This will check whether nicotine release is proportional to the nicotine applied for all three extracts. Assuming this is the case, a second experiment would be made using that extract - 1. (iii) c, b or a - and testing this with each additive singly at one level only. This will settle the optimum extraction procedure and whether and if so which additive is necessary.

4. Study all conditions for maximum transfer.

(i) Fix heat input, type and amount of extract and additive applied, tube material (Al. foil), tube dimensions (70 x 4 mm), measure nicotine transfer for tube on its own (Fig. 3 device) and tube with added nucleation chamber (Fig. 1 device).

This will check the necessity for a nucleation chamber in combination with a hollow tube device.

(ii) Fix heat input, type and amount of extract and additive, type of device (Fig. 3), dimension (70 x 4 mm) and wall thickness. Study nicotine transfer in terms of material of tube

(a) Aluminium
(b) Pipe clay.

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(iii) As (ii) but varying external dimension of tube for

(a) Aluminium
(b) Pipe clay.

(iv) Fix type and amount of extract and additive applied. Fix dimensions and wall thickness of tube at optimum obtained from 4(iii). Study nicotine transfer in terms of heat input for

(a) Aluminium
(b) Pipe clay.

5. In addition to tobacco extracts this approach can be extended to include

(i) Laminated tobacco;

(ii) Extruded tobacco, e.g., in tube form or as a bundle of filaments;

(iii) The addition of an extract of tobacco or of powdered tobacco to either of the above forms.

6. Parallel with this investigation studies will be made of the effect of additives, e.g., non-polar compounds to modify the rate of physiological absorption of nicotine. This will probably be done by individual smoking of devices.

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PART 2

It is apparent that the requirements for devices illustrated in Figs 1 and 3 of the draft Provisional Application are mutually incompatible. For aerosol production in the Fig. 3 device the principal requirement is a tube of low thermal conductivity so that there is a steep temperature gradient along the tube. For the Fig. 1 device, in which the tube is packed, aerosol production seems to be dependent upon nicotine vapour emerging into the nucleation chamber from the column, which must therefore be held at a sufficiently high temperature. This calls for a central containing tube of high thermal conductivity and consequently a higher heat input.

For this reason the experimental approach to the Fig. 1 device must be different.

In all the following proposed experiments the aim is to find conditions for maximum nicotine transfer.

7. Effect of packing density.

Fix tobacco (Sample W. 428), carrier tube material (copper), dimensions (25 x 4 mm), dimensions of aerosol chamber (30 mm long x 30 mm circumference).

Fix heat input (at a value greater than that for Part 1).

Study effect of packing density of cut tobacco on nicotine transfer at the extremes of range obtainable. The amount of tobacco contained in the tube is probably most easily determined by weighing after packing.

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8. Study of effect of heat input.

Fix tobacco packing density at optimum (derived from 7), carrier tube (material, dimensions), aerosol chamber (dimensions).

Study nicotine transfer as a function of heat input.

NOTE: From indications already obtained it appears necessary with a device of type Fig. 1 to use a short central tube in order that nicotine should be delivered from the first puff. With longer tubes condensation rather than nucleation occurs in the early puffs. Therefore, in order to provide an acceptable amount of nicotine (say, 1.5 to 2 mg per device) this short length of narrow tube must contain a source rich in nicotine. This might be achievable (a) by the use of a tobacco of very high nicotine content, or (b) by enriching a more normal tobacco with relatively large amounts of added nicotine.

It appears from this that a device of type Fig. 1 is unlikely to be successful. Experiments 7 and 8 should give sufficient information to decide whether this is the case. If success appears attainable then an extension of this approach can be easily envisaged.

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