

December 30, 1959.

*Sup. J. H. U.
with Griffith*

Sir Charles Ellis, M.R.S.,
Westminster House,
London.

Dear Charles:

I have for reply your letter of December 7.

Firstly, in connection with your comments about extraction of tobacco, we are aware of Brown and Williamson's feelings that Spring, Alpine, and possibly Kent K-90 contain within their blends tobaccos which have been extracted. During the visit of some of our people to Louisville prior to the Tobacco Chemists' Conference in Lexington, they took with them small quantities of cut tobacco which de Souza and Rice had extracted in their laboratory, each tobacco having been extracted with a different solvent with the exception of one which was not extracted. The purpose of this was to find out how Brown and Williamson identified extracted tobacco, as our own people have not been able to differentiate it under a microscope from normal tobacco. The five coded samples were submitted to the girl technician in the B. & W. research laboratory who had recently been trained to do this work. She was unable to correctly identify the non-extracted sample. However, the samples were later submitted to Dr. Griffith and to the person at the University of Kentucky who had worked with Dr. Griffith and both people individually and separately correctly identified the non-extracted sample. They went even further and suggested that certain samples were more completely extracted than others and their observations were in line with our experimental results. We at first had some skepticism about their ability to distinguish treated from non-treated tobacco but as a result of the work of Griffith and his assistant at the University of Kentucky, we have altered our opinion. Incidentally, Griffith along with Jarboe and Johnson will be visiting us during the week of January 10 and we propose to question Griffith more closely about his technique.

We have not attempted any extractions similar to that of the Schloetting process, but we would speculate that in view of the relatively short time of contact of the tobacco with the steam-ammonia vapours, as contrasted to time required for solvent

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extraction, we would not expect any significant removal of tobacco constituents, except nicotine of course, nor, therefore, any subsequent great reduction in smoke tar. The relatively high temperature might melt some of the cutin as well as remove volatiles but since the latter are recycled we would expect a negligible overall effect on tar. We might mention in passing an interesting observation concerning the effect of extracting cigarettes with hot toluene (87-88°C). We obtained cigarettes which were extremely hard (after being freed of toluene and returned to normal moisture content) and which exhibited a pressure drop twice as great as that of the original cigarettes (5.4 inches of water vs 2.5 inches). We suspect this may be to a large extent a heating effect since toluene extraction at room temperature failed to produce a similar effect.

Secondly, you wonder if we have any further data regarding the effect of holes or slits on the reduction of tar in the smoke of such cigarettes. We have run a number of such experiments and the results are summarized in the attached table. It will be readily seen that with one exception the amount of reduction of tar is appreciably greater than the reduction of nicotine in the smoke. It will also be observed that within any one series investigating varying numbers of slits or holes, there is not a good correlation between the number of slits or holes and the reduction in tar or nicotine. This would appear to be largely the result of imperfect puncturing or slitting of the paper or the fact that the tobacco tends to close a number of the openings. There is no question, however, that holes and slits reduce the amount of tar and nicotine found in the mainstream smoke and that this reduction is greater for tar than it is for nicotine.

We do not quite see how holes or slits can affect the amount of the re-polymerization products in relation to the direct products since the holes and slits are located quite close to the mouth end of the cigarette. We believe that this reduction in tar is caused entirely by the lesser amount of air passing through the burning zone which fits in with your theory of combustion. The ratio of products formed by re-polymerization, to total tar should, we think, be the same regardless of whether the cigarette is perforated or not. The nicotine, however, would appear to be a different story and we have had some thoughts on the subject, based upon our work on extraction of tobacco and on smoking cigarettes made with extracted tobacco. We are beginning to feel that nicotine is present in tobacco in two different forms; one as a "free" or readily available form and the other as a "tied" form. By "tied" form we do not necessarily mean all the nicotine which is chemically combined, but that which is less readily transferred in the form of nicotine to the mainstream smoke. It would appear that the nicotine in the tobacco which is readily available is transferred to the mainstream smoke to the extent of about 35%, whereas that which is "tied" is transferred only to the extent of something under 15%. We think

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perhaps this "free" nicotine is more readily volatilized and that this volatilization continues during the free burning of the cigarette with resultant accumulation ahead of the burning zone. During the puff it is then picked up and drawn into the mainstream of the smoke. We would guess that the presence of slots or holes would have little effect on this nicotine. The "tied" nicotine on the other hand is released only in the burning zone or at least very close to it and as mentioned above, the transfer of this nicotine to the smoke is less than 1%. Since the amount of air passing through the burning zone is less if a cigarette is perforated, then the amount of this "tied" nicotine transferred to the mainstream smoke is less for perforated cigarettes. Obviously the foregoing represents a considerable amount of speculation but we believe that we have some evidence for the "free" and "tied" nicotine and have developed the theory from this. We intend to carry out experiments heating tobacco in a stream of nitrogen at various temperatures in order to determine among other things how much nicotine can be driven off ahead of the burning zone. Furthermore, our work with tar and nicotine in the smoke from cigarettes smoked to different butt lengths may possibly show different ratios of nicotine to tar at different lengths.

We have not replied to your letter of August 19 regarding the amounts of benzpyrene found from cigarettes smoked to different butt lengths because we have run into various problems with the determination of benzpyrene. However, we believe we have solved these problems during the past few weeks and have resumed the experiments. We have given up the use of picric acid in the separation of polycyclics from condensed smoke and are now using only column and paper chromatography with quite good results. I believe that Dr. Hughes is pretty well up to date on this work. In order to check our recoveries we are now using labelled C^{14} benzpyrene in each of our analyses and have been quite satisfied with the results. We are, therefore, repeating most of the work done on 74 mm and 80 mm. cigarettes smoked to varying butt lengths for the determination of benzpyrene in the smoke. One thing that we are fairly certain of is that there is no reduction in benzpyrene on a per gram of tar basis from cigarettes made from n-hexane extracted tobacco. There is, of course, a reduction in benzpyrene on a per cigarette basis equivalent percentage-wise to tar reduction.

We will be most interested in having any comments you wish to make on the foregoing.

With kind regards and all the best for the New Year,

Yours sincerely,

LCL:BM
Encl.

c.c. D.S.F. Hobson, Esq. (2)

L.C. Laporte
Research and Development

- Hugh Anderson may be interested in receiving a copy of this letter. *BM*

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