IN REPLY REFER TO

WAR DEPARTMENT,
OFFICE OF THE CHIEF SIGNAL OFFICER,
WASHINGTON.

Engineering Division
and Research
Jomtho

30 September, 1919

Office, Chief Signal Officer of the Army

Col. George Fabyan, 160 W. Jackson Blvd., Chicago, Ill.

Printing Telegraph Cipher

1. In compliance with your telegraphic request received yesterday, the Chief Signal Officer directs me to furnish you with a statement concerning the Signal Corps method of allotting parts of the cipher tapes used in connection with the Printing Telegraph Cipher to the various offices so that in one day's business no overlap will occur.

2. As you have already been informed, the "A" tape is the longer of the two tapes. Let us say, for example, that the "A" tape has a total of 591 characters and the "B" tape has a total of 590. The total number of characters which can be produced by these tapes is evidently 591 times 590 or 348,690. This number of combinations is calculated to be more than enough for one day's business of all four stations, which we assume in this example is the total number of Printing Telegraph stations to be provided with a cipher key. Assuming that both "A" and "B" tapes are started with the same setting, "001", and assuming that both tapes make one revolution, when we reach the 592nd character we again find on the "A" tape "001" but on the "B" tape "002." By the same process when one more revolution of the "A" tape has been completed so that it again reads "001", the "B" tape reading will be "003." If we assume that the day's business of all four stations is equal, it will be obviously necessary to allot $\frac{1}{4}$ of the total number of possible combinations or about 87,172 combinations to each station. In other words, if we were to sit down and make one long single tape by constantly adding the "A" tape and the "B" tape together until we had returned to the point where the setting "001" on the "A" tape would coincide exactly with the setting "001" on the "B" tape we would have a third tape of 348,690 characters which we could cut into quarters and assign the first quarter to "A" station, the second quarter to "B" station and the third quarter to "C" station and the fourth quarter to "D" station, or what is more convenient and practical, we can divide the total number of characters on the "A" tape by four and thus determine the starting points on the tape to be assigned to the four stations. Thus 591 divided by 4 gives 147 plus so that the starting points are 147 characters apart on the "A" tape. It is quite obvious that by starting the "A" station, for example, with "001" as its "A" setting and with "001" as its "B" setting, and starting the "B" station day's business with setting 147 on the "A" tape and "001"

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on the "B" tape, and starting "C" station with 294 on the "A" tape and "001" on the "B" tape and starting "D" station with the setting 441 on the "A" tape and "001" on the "B" tape, we will have insured the allocation of ¼ of the total number of combinations to each station without any overlap taking place between the part alloted to the "A" station and that alloted to any other station, if the stations start to encipher each consecutive message at the point where each succeeding message stops. To show that this is so, there is appended hereto a table based upon the supposition that the "A" tape is 12 characters long and the "B" tape is 11 characters long, and that 132 characters will cover the entire day's business of the four stations. By our rule, if there were four stations, we might instruct "A" station to start sending its day's business with the setting "001" on the "A" tape and "001" on the "B" tape; the "B" station with the setting "004" on the "A" tape and "001" on the "B" tape; the "C" station with the setting "007" on the "A" tape, "001" on the "B" tape, and, the "D" station with the setting "010" on the "A" tape and "001" on the "B" tape, and, by this means, as seen from the table appended, we would have assured the allotment to each station of exactly ¼ of the total number of characters obtainable by the combination of these two tapes.

The red marks in the table indicate the limits of the combinations assigned to each station. In this case, as by our rule, the total number of combinations is obtained by multiplying the total number of characters on "A" tape by the total number of characters on "B" tape, giving us 132 combinations, ¼ of which are alloted to each one of the stations. It is seen from this table that if the day's business is confined by order to the band of characters alloted to each station, there will be no overlap in any place. The table, of course, should be read from top to bottom in each column and the columns should be read in order from left to right, so as to obtain a complete sequence of combinations as they would actually appear by the addition of these two tapes.

3. It is to be noted that in practice we do not assign the combination "001" on the "A" tape as a starting point for any station. If two tapes were used, "A" 781 and "B" 486 long for example, it is quite possible that the allotment to the four stations would read

	"A"	"B"
"A" station	029	001
"B" station	181	001
"C" station	405	001
"D" station	585	001

d upon as the day's business for each station, some stations naturally being required to handle more business than others and hence needing a greater allotment of combinations. depending upon how many messages could be counted.

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4. In case this explanation is not satisfactory, request that you communicate further on the subject.

J. O. Mauborgne,
Lieut. Col., Signal Corps

Encl.