ANSWERING TIME RECORDER AND ANSWERING TIME RECORDER WITH TRAFFIC WEIGHTING APPLIQUE GENERAL DESCRIPTIVE INFORMATION

1. GENERAL

1.01 This practice describes the principles of operation of multiline answering time recorders, noting certain basic inaccuracies that can occur in the measurements made by these devices, and then describes an applique circuit which can be applied to the multiline ATR to enable correct results to be obtained.

2. ANSWERING TIME RECORDER

Description and Operation

2.01 Answering time recorders (ATRs) are devices used to measure the promptness with which telephone operators answer lamp signals on operator-handled calls and services. In this way, ATRs measure one aspect, called "speed of answer," of the quality of service which subscribers receive.

2.02 Speed of answer is concerned with how long a subscriber waits to get an operator. It is expressed in terms of the per cent of answers with a delay exceeding a certain number of seconds. For example, at a toll switchboard the speed of answer objective might be stated as, "seven per cent over 10 seconds," meaning that on seven per cent of the calls the subscriber waited longer than 10 seconds to get an operator. For other types of switchboards, the objective interval may be 20 seconds rather than 10 seconds and in one type of application an interval of 5 seconds is used.

2.03 The solid-line portions of Fig. 1 represent an ATR in functional block form. At the left of Fig. 1, signaling leads (usually lamp leads) from 25 line or trunk circuits enter the connector of the ATR. When one of these 25 lines or trunks originates a call, a start signal appears on its signaling lead. This start signal causes

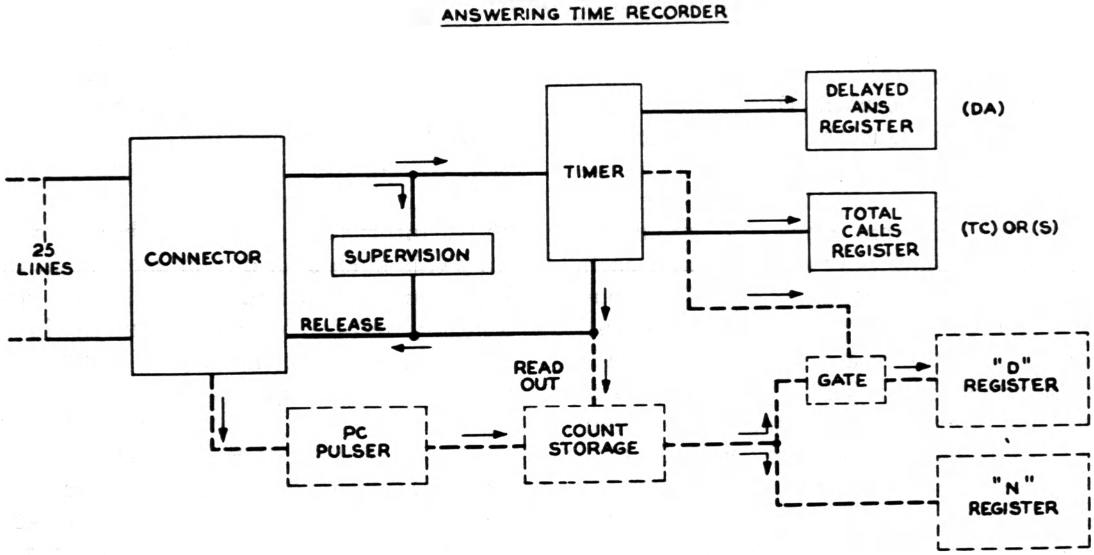

Fig. 1 – Answering Time Recorder

the connector to extend that signaling lead into the timer and into the supervision circuit of the ATR. Here, this start signal causes two actions to occur. One, the start signal is scored on the total calls (TC) register. Two, the timer is placed into operation.

2.04 If the call is answered promptly by an operator, the start signal is thus removed promptly from the signaling lead. This causes the timer to return to normal and the supervision circuit to release the connector, returning the ATR to its normal idle condition. However, if the call is not answered by an operator before the timer times out, the timer causes the delayed answer (DA) register to operate, after which the ATR returns to its normal idle condition.

2.05 Means are provided in the connector to lock out calls which may originate while a prior call is being timed so that such calls cannot interfere with the measurement being made.

2.06 Means are also provided in the connector to prevent a call which has remained unanswered from entering the ATR when it becomes idle and so being incorrectly measured.

Results of Answering Time Recorder

2.07 As the ATR operates, as described in the foregoing paragraph, there is accumulated a record of the number of calls measured (TC) and, of these, the number of calls getting a delayed answer (DA). From this it is intended that the per cent slow answer be calculated by dividing the DA figure by the TC figure and expressing the result as a percentage.

2.08 Unfortunately the ratio DA/TC does not ordinarily represent the true per cent of delayed answers which occurred on the 25 lines or trunks being observed by the ATR, for the following reason. On most lines or trunks, especially during the busy hours of the day, calls occur frequently enough so that there is a good probability (chance) that ***additional*** calls will occur on one or more of the 25 ATR input leads while a call is being timed. These calls are locked out by the ATR connector so as not to let them interfere with the call being timed and thus do not get scored on the TC register. Thus, for some busy hour the TC register might score only, for instance, 80 per cent of the actual total calls occurring on the ATR input leads. Of course, if this also caused the DA register to score only 80 per cent of the real delayed answer value, the resulting "per cent slow answer" would still be correct since 80 per cent of DA divided by 80 per cent of TC gives the same answer as 100 per cent of DA divided by 100 per cent of TC.

2.09 However, in a situation when the ATR scores, for example, only 80 per cent of TC, it will be very likely to score even less of DA because, ordinarily, delays occur most often only in the very busiest moments of a busy hour and at such moments the ATR may be able to score, for instance, 60 per cent of the calls offered to it. This, of course, gives a "per cent delayed answer" which is only 60 per cent/80 per cent, or three fourths of the actual "per cent slow answer."

2.10 Since the number of calls missed will vary during the day, being least during the side hours and being most during the busy hours, an ATR which operates for several hours may actually get something like this:

First hour	90% of DA	95% of TC
Second hour	85% of DA	90% of TC
Third hour	40% of DA	60% of TC
Fourth hour, etc	50% of DA	75% of TC
Total day	60% of DA	75% of TC

2.11 Furthermore, it is apparent that since the number of calls missed will vary from moment to moment even within a single hour, the ATR will tend to get various percentages of DA and ***other*** percentages of TC from moment to moment during the hour, just as it does from hour to hour during the day.

2.12 From the foregoing it may be seen that while the basic principles which underlie operation of the ATR are correct, it is very sensitive to its own overloading. Except in applications where the calling rate is unusually low, the ATR does not give correct results either for short intervals such as an hour, or for longer intervals such as a day or month. In higher calling rate applications, the ATR is, nevertheless, a handy tool for force adjustment since it readily indicates fluctuations in the "per cent slow answer," even though its indications are only relative rather than absolute. Even in such limited application, the ATR data should ***not*** be used unless allowance is made for the expected statistical variation of even these relative results depending upon the number of measurements taken. This is discussed briefly in this section in Part 4, Sampling.

3. ANSWERING TIME RECORDER WITH TRAFFIC WEIGHTING APPLIQUE

Method of Operation

3.01 A traffic weighting applique (TWA) is a device which is attached to an ATR to modify the results obtained by the ATR so as to take into account the calls missed by the ATR and thereby to cause a true "per cent slow answer" measurement to be obtained.

3.02 The dotted-line portions of Fig. 1 represent a TWA in functional block form. The TWA consists of the following functional elements. A peg count (PC) pulser capable of recognizing substantially every start signal which originates on any of the 25 ATR input leads, whether or not these calls are actually being measured by the ATR; a count storage device capable of storing the peg count from the PC pulser and, upon receipt of a "read out" command from the ATR, capable of passing this count into the number of calls (N) register or, if the gate is open, into both the (N) and delayed (D) registers.

3.03 The TWA operates in conjunction with the ATR as follows. Whenever the ATR starts to measure the delay on a call, the PC pulser and the count storage device count the call being measured as "1" and then count the number of additional calls (if any) that originate while the ATR is occupied with call 1, as 2, 3, 4, etc. At the end of the objective interval (5 seconds, 10 seconds, 20 seconds, depending upon the type of service being observed), the accumulated peg count is read out into one or both of the N and D registers on the following basis. If the call being measured by the ATR is delayed beyond the objective interval, the ATR timer will time out, opening the gate and allowing the count to enter the D register. If the call being measured by the ATR is answered before expiration of the objective interval, the ATR timer will not have timed out, the gate will be closed, and nothing will enter the D register. Regardless of whether the measured call is delayed or not, the count always enters the N register.

3.04 When a TWA is added to an ATR some minor circuit changes are made in the ATR. Of these, the most significant is a change in the release of the circuit. An ATR working alone releases itself automatically before expiration of the objective interval if the call it is measuring is answered before expiration of the interval. This is referred to as "automatic release" type of operation. An ATR working with a TWA is modified so that it always holds itself busy for the full objective interval when it makes a measurement, no matter how quickly the measured call may be answered. This is called "constant holding time" type of operation. With constant holding time operation, even when the call being measured is answered quickly, the TWA is given a full objective interval in which to accumulate calls which will be scored nondelayed answer, just as it is given a full objective interval to accumulate calls which are to be scored delayed answer when the call being measured receives a delayed answer. In this way there is obtained unbiased treatment of all calls by the ATR-TWA and the highest accuracy is attained.

Results of Combined Operation

3.05 The TWA, in operating as described above, applies a traffic weighting correction to the ATR result as each ATR measurement is made. It counts the number of calls that arise on the 25 ATR input leads while the ATR is making each measurement. Then, after the ATR finishes the measurement, the TWA causes not just one, but one ***or more*** operations of the total calls and delayed answer registers (if the measured call received a delayed answer) or just the total calls register (if the measured call received a prompt answer). In order to avoid confusion with the delayed answer (DA) register and the total calls (TC) register of an unmodified ATR, the corresponding registers of an ATR with TWA are called (D) delayed and (N) number of calls. A third register (S) for size of sample is also provided. The purpose of this register will be explained in a later paragraph, but the S register is really the TC register with a new designation.

3.06 TWA operation by the principle of traffic weighting certainly seems proper enough in light of its similarity to the procedure widely used for obtaining weighted averages of many kinds throughout the Bell System. (Actually it has been verified by making recordings of "speed of answer" on many thousands of calls and comparing these with the result given by the machine.) Concern is occasionally felt, however, when it is first realized that the ATR-TWA combination can, and often does, measure one delayed call accompanied by, for example, four calls which were answered promptly. Yet the machine will score five delayed-answer calls on its D register. How is this possible?

3.07 The procedure is quite proper. Suppose there are a large number, for instance, a thousand occasions during the month when the ATR has one delayed-answer call and four nondelayed-answer calls appear on its input leads in one objective interval. We don't know, of course, which call will actually get measured on each of these occasions. It might be the delayed-answer call or it might be one of the nondelayed-answer calls, depending upon which call happens to come in first and get through the ATR connector first. (The rest are locked out.) We do know, however, that we have four times as great a chance of measuring one of the nondelayed-answer calls since there are four of these and only one delayed-answer call. Thus we know that, ***on the average,*** out of a thousand tries, the ATR will catch one of the nondelayed-answer calls 800 times and will score the whole group of five as nondelayed answer, allowing the one delayed-answer call to slip by undetected. On the remaining fifth of a thousand tries the ATR will measure the delayed-answer call and on these 200 occasions will score everything as delayed answer.

3.08 Summing up the results of this action, the following is seen.

NUMBER OF MEASUREMENTS	CALLS SCORED DELAYED (D)	NUMBER OF CALLS COUNTED (N)
800	0	4000
200	1000	1000
Total 1000	1000	5000

The indicated "speed of answer" is 1000/5000 or 20 per cent. This is, of course, correct since we had one delayed answer out of each five calls or 20 per cent delayed. This principle can be followed through for any combination of delayed-answer and nondelayed-answer calls one cares to imagine and the result will still be correct. Thus, the ATR-TWA combination, by doing the wrong thing the right number of times, gives a result which is very accurate after enough measurements are taken for the law of averages to apply.

4. SAMPLING

Size of Sample

4.01 From the foregoing it is apparent that the accuracy of the speed-of-answer measurement depends upon how many measurements are made. A register designated S for size of sample is provided to count the number of measurements made. The following table indicates approximately the number of calls which must be measured to provide various degrees of accuracy.

SPEED OF ANSWER	NUMBER OF MEASUREMENTS REQUIRED FOR PER CENT SLOW ANSWER TO WITHIN ±1.5 PER CENT	±0.5 PER CENT
3 per cent	320	3200
4 per cent	420	4200
6 per cent	610	6100
8 per cent	800	8000

The number of measurements listed will provide the accuracy indicated 90 per cent of the time.

4.02 The foregoing table indicated that some caution should be observed against taking too seriously the per cent delayed answer shown for a single busy hour, for example. Data for several hours has increased significance.

4.03 Even when applied to an unmodified ATR, the foregoing table is useful as a guide in considering the fluctuations in the ***relative*** per cent delay indicated by the ATR for short periods of time. It should be borne in mind, however, that the inherent error in an unmodified ATR is not corrected by taking a large number of measurements.