A Field Artillery forward observer moving with an infantry company in the attack throws himself down behind a small outcropping of rock. He glances at the plastic coated map in his right hand; he sets the dials on a small device he holds in his left hand. He presses a button. In less than 3 minutes lethal volleys from two batteries of Field Artillery fall on the area occupied by the enemy recoilless rifles and automatic weapons which have been holding up our advance. The enemy weapons are silenced. The observer again turns dials on his hand message generator and presses the "SEND" button. He has reported the results of the fire.

Three miles to the rear, the operations officer in the Artillery battalion fire direction center turns to his battalion commander and says, "That completes the fifteenth fire mission we have fired today without adjustment, but with excellent effect. Our observers are reading the maps well; and of course, our computers are computing the firing data with deadly precision. The results of that mission will by now be stored on the magnetic tapes at Division Artillery Headquarters and soon will be input to the periodic intelligence program."

Computers Moving Into The Field Artillery

Yes. Computers are moving into the Field Artillery; and we are studying the implications and applications of the computers to Field Artillery. It is my purpose to tell you something of how we expect to fit computers into tactical field operational doctrine and training in the years immediately ahead. I am in the field artillery and in a strict sense I am qualified only to speak of the applications for computers in that combat arm of the Army. However, the Artillery's computer effort is a part of the total effort and I believe you would like to have a brief glance and the big picture first, before we narrow down to a single combat arm.

The Army's ADP System

The Army has undertaken an ambitious Automatic Data Processing System development program in which we foresee having the field army served by a number of computers working in a plan combining independent and integrated action. The total number of tasks foreseen for our ADP system numbers in the area of one hundred and ranges from the complex mathematics of our required ballistic solutions, computed entirely in the forward areas, to the data processing of logistical requirements dependent on a network of computers and entry devices.

I am sure that you can all form an idea of the tremendous potential savings in time and money available in a computer system encompassing an entire theater of operations, and even the continental United States, that is, the "Zone of the Interior". In past wars we have had cumbersome depot systems stretching from the home factory to the forward combat zone. From the large depots at the port of debarkation a series of successively smaller depots stretch forward. Maintaining supplies to fill this long pipeline was a formidable task. Knowing what you had available was an equally formidable task. Recall that where industry is faced with this same problem, industry is not faced with constant movement of depots, movement of the forward end of the pipeline, rotation of personnel, and accident as grave as bombing and shelling; nor is industry faced with a communication system that is in a state of great flux. In sum, then our depot system and supply problem in a theater of operations has always been inevitably costly and inefficient. Enter data processing. With rapid accounting, with speedy and accurate reply to queries from anywhere in the system, and perhaps best of all, with powerful and valid extrapolation and prediction of requirements we can have good management and timely execution; we can probably cause whole lines of depots to fall. We can save the huge quantities of stocks consumed in just filling the pipeline.

We have great hopes for the data processing possibilities ahead for us in a field army - in material accounting and in personnel and operational accounting of all kinds.

Now, having sketched out for you the larger picture, the field army and the whole scheme of computers we plan for it from the large scale to small scale, let me return to my own field and sketch out what we see in "COMPUTERS FOR ARTILLERY".

Computers in the Field Artillery

The Field Artillery supports the other two ground gaining combat arms - Infantry and Armor - and is in turn supported by the remaining arms and services. Therefore, by logical extension of my remarks you can readily derive from an understanding of the artillery's computer problems an understanding of the place of computers in the full
field army.

Among the combat arms - Infantry, Armor, and Artillery - the Artillery holds a unique place with respect to automatic digital computing. The Artillery stands at that point in the field army at which technical, mathematical computing meets automatic data processing - the instrument of logistics, battlefield management, and command. (Figure 1).

Requirements for Mathematical Computing

First, we will look at the Artillery's requirements for mathematical computing. Second, we will glance briefly at the type of computers we have in mind and a possible scheme of location; third, we will look at the Artillery's requirements in data processing; and finally, we shall look at a portion of the complete system within the Field Artillery as it might look a few years hence.

Our requirement for technical, mathematical computing falls into three fields: survey (where are we on the ground?); meteorology (how strong is that head wind?); and firing data (at what angle shall we point these cannons and rockets?). (Figure 2).

Finding the answer to each of these questions presents a straightforward mathematical problem. Survey data and meteorological data are normally furnished to the artillery battalion by higher headquarters, and so will be discussed when we come to a discussion of the complete artillery system of computers. However, fire control data, based on survey and meteorological inputs, is computed at the artillery battalion and battery - down where the howitzers, guns, and rockets can be found. We will begin at the forward end and discuss fire control.

At this point I think I must take a minute to define briefly the organisational structure of the artillery so that we may use three simple terms - battery, battalion, and division artillery for the rest of the paper. The basic firing unit in the Field Artillery is the battery, which we can say includes 6 howitzers (guns) and is represented by the symbol shown in Figure 3.

The next larger unit is the Field Artillery battalion which includes two or three batteries and is shown in Figure 4.

And finally, the third and last unit we need to consider is the division artillery. A division artillery will control a number of battalions, say five or six. Figure 5 shows the organisation of a division artillery.

Fire Control Computer

What computers are we planning for our mathematical requirements and where will we place them? For use within batteries and battalions and primarily in the production of firing data we are now testing a small ruggedized computer, FADAC, Field Artillery Data Automatic Computer. FADAC has a rotating memory in the 4096 word class. The computer is designed to give us a complete ballistic solution (integration of half a score of differential terms representing the interacting factors of angle of departure, velocity, mass, weather, and so on) in less than the time of flight of the projectile. We expect great accuracy from the solution because the program combines the best of proving ground methods (full mathematical solution to the equations of motion) and the best of practical experience. The computer will store, and constantly update, the empirically derived difference between predicted and proven results. The end result, we hope, will be first-round accuracy for our cannons and improved accuracy for rockets. It is also adaptable to other problems and can be termed a general purpose computer. For all of our artillery computers we intend to have removable and changeable labels on our operating panels so that the soldier operator can talk exclusively in terms of his own problem. Reading in a new program is accompanied by attaching a new set of labels for the operator's buttons. We thus have the advantages of being special purpose at the moment and general purpose through the day.

Response To Fire Requests

You must bear in mind that in ground combat we normally fire cannon as area weapons. That is, we mass the fire of a dozen or more cannon on small areas (100 meter, 200 meter circles). By first-round accuracy we then mean that the impact pattern of the first volley fired by the battery or battalion will include the target and produce lethal effect against it. (Figure 6 and 7).

Let us accept that immediate, accurate response to a requirement to fire is the Field Artillery's primary interest in computers. How does this affect the development of a computer system? We can return to the forward observer we met at the beginning of this talk for an answer to the question.

First let us look at the complete process of firing and then consider the actors who are responsible for action at each step. In Figure 8 are the elements of the problem. Here is an enemy target; the target is seen by an observer; the observer requests the battalion to take an action; the battalion provides an officer who makes a decision and assigns the firing to one or more batteries; data is computed; and the batteries fire.

All of these actions can be speeded by their inclusion in a complete computer system. A complete system can help us avoid error. However, only the central computer is indispensable to the achievement of first-round accuracy; we must have a computer for the mathematics of the ballistic solution.

An Automatic Fire Request/Response System
Let us look again at the process, with automatic devices in operation throughout. Figure 9 shows the full span. First is the observer’s request for fire. The observer uses an automatic device to report the location of the target. (Marked “Message Entry” on Figure 10). He could use the telephone or radio with only a small price in speed (and, of course, a risk of human error in number transcription — coordinate location of the target, and so on). Second is the decision and order to fire. We receive the mission and display it electronically on a device at the battalion which I shall call an electronic map and switch device (Figure 11).

The configuration of this device is under study. Although the display is automatic, human decision (to fire or not to fire, and how much) remains with the gunnery officer. Transmission of the gunnery officer’s commands to the firing battery is automatic. Removing the automatic aspects and returning to inspection of a paper map (followed by telephone or radio to the battery to fire) would cost in time but not accuracy (discounting transcription error). And finally, there is at the battery a display unit on which can be displayed a complete set of fire commands and data for the guns. The complete set includes gunnery officer instructions to the battery, and the output of the computer located at the battery or battalion, or both. With only a small loss in speed (and again, possible human error) instructions and data can go to the guns by voice (telephone or radio). We retain accuracy as long as the data is generated by computer.

Recapitulating, we can say that without loss in first-round accuracy we can delete from the system the observer’s message entry device, the electronic map, and switch device, and the battery display unit. We believe in the possibilities of a complete system; but our greatest tactical gain — accuracy — can come from a decentralized array of ballistic data computers not linked by data transmission systems (other than the old fashioned kind developed by Alexander Graham Bell).

We wish to play the game both ways. We want the benefits of a complete system if we can have them; but knowing the uncertainties of the battlefield we wish small computers well forward — in batteries and battalions — to compute firing data. This concept of being able to work our computers either in a system or independently we call the federal-state approach.

Implications Of Increased Accuracy

There are a number of significant implications in a more accurate solution to the cannon and rocket fire control problem. The first is that the Artillery will be able to fire many more “immediate fire for effect” missions, missions in which no adjustment by the observer is required even though no recent registration (“zeroing in”) has been accomplished. The obvious gain in effect on the target is perhaps matched by the time and ammunition saved. Observers can fire many more missions in a given period of time.

A reduction in the number of registrations (a procedure for determining corrections of the moment) will bring a number of benefits. Logistically we will save in the ammunition moved forward. How many thousands of rounds were consumed in Korea and World War II in registering batteries and re-registering them repeatedly? We know the cost of one round of ammunition at the factory in Virginia or Ohio. But what is the cost of that round delivered to the 38th parallel in Korea? I do not mean to imply that registration will not be necessary at times; but the requirement should be materially reduced since the computer gives us a pure ballistic solution in which errors are removed or isolated to a degree now not possible using the approximations presented in firing tables.

Fewer registrations will mean more surprise. Units can move into new positions and be ready to deliver effective support without that tell-tale pre-firing registration procedure. Tactical mobility will be increased. In the past, impending darkness and other restrictions on registration in a new area have often influenced the displacement of Artillery units. Time will be saved; registrations can be time consuming. Under present techniques missions sometimes have to wait or registrations have to be interrupted.

Unobserved Fires

In addition to the response to requests for fires called in by observers, the Field Artillery frequently has to place fires on areas not under the observation of a trained artilleryman. The fires may be on call from supported units or may be part of a predetermined schedule of fires. In any event the utmost in accuracy is required. In the past this accuracy has not been easy to achieve. The normal procedure is to record basic data for all targets and update the data every two hours as new meteorological information is received. The bookkeeping can become extensive. The pressure of events can make it impossible for fire direction personnel to find time to update data for their on-call fires; and even when manual procedures are perfectly executed the results are limited to firing table accuracy.

With a fire control computer we will be able to store the location of many targets. Basic data for fire on the targets can be generated. Correction factors determined from firing can be applied to new conditions. Receipt of data on newly determined meteorological conditions will be followed by an immediate updating of fire commands for all on call fires. The battalion will be able to repeat fires on old targets or place them on new targets nearly as rapidly as the guns can be laid (aimed).

The handling of relatively large target lists is a problem in data processing and fire planning. I should like to defer discussion of these
Missile Computers

Missile fire control also presents an obvious application for high speed computers. One missile fire control computer - the Jukebox for Redstone - has been delivered and is in the hands of operational units. The Jukebox computes, in five minutes, the complex mathematical problem requiring two trained operators working with electric desk calculators two and one half to three hours to complete by hand. In the case of missile computers the gain is in speed. The hand solution produces accurate results for the Redstone but is intolerably slow. Every missile type will have to be assigned an appropriate fire control computer. Because all computers are potentially general purpose machines, the same computer that computes the fire control problem for one missile may be reprogrammed to compute the problem for another. There are technical limitations in some cases, of course. But there will inevitably be a trend toward standardization and limitation of types of digital computers for the Army.

Topographic Survey Computing

Topographic surveys in the battle zone are accomplished by the combined effort of survey teams at successive organization levels. The battalion has a survey function, the division Artillery has a broader function, and so on. Accurate and rapid exchange of information between the survey echelons is imperative. Therefore the Artillery survey requirement presents a problem in both straightforward mathematical computing and in data processing.

The end product of the Artillery survey system is the precise location in three dimensions of points in the areas of the Artillery battalions, and the target areas plus the establishment of a reference direction. To reach this end the survey system must build a network of computations and establish a set of centers for exchange of data. There is currently under development a computer-supported system for this task. Regardless of whether the complete integrated task can be performed automatically in the near future, isolated computers at the appropriate various levels, supported by conventional communications, the "federal-state approach", will speed the production of data required for accurate artillery fire.

We are studying message entry schemes and believe that the battalion survey requirements might be met by a device having access to the battalion computer in the battalion operation section, the fire direction center; or it might be better to allocate a computer to survey at battalion under some conditions. In any event there could be associated with the battalion computer in the fire direction center, a survey panel for the processing of survey problems when the scope of these exceeds the capability of the fire control panel. At division artillery level it is possible that the survey requirement, with particular reference to the work of advance parties during displacements, will be such that a small computer individually vehicularly mounted must be assigned to survey. This computer would itself be served by both message entry devices in the hands of survey parties and by the survey control panel on the computer. The small survey computer would, of course, have access to the medium size computer at division artillery headquarters.

Meteorological Data For Fire Control

The preparation of meteorological data for the artillery has been developed and refined over the years. Yet, the timely preparation of the required data by hand necessitates the use of graphic methods and approximations that cannot possibly give the precise results to be expected from a high speed machine. The application of computers to generation of meteorological messages for artillery fire control is an immediate prospect. The dissemination of the results automatically through the system is the obvious corollary.

Meteorological data is generated at division artillery and higher headquarters. The "met" sections, almost alone among our Artillery elements, have an on line computing problem with a real-time consideration. (There are radar tracking problems with a real-time aspect). We track a rising balloon which is constantly transmitting to the ground station. We can solve this problem either by the assignment of a small computer to the meteor section (which may wish to locate at a point well away from division artillery headquarters), or we can use real-time registers and interrupt features on a medium scale computer at division artillery, or we can digitize the data from the analog input at the met station and transmit it to the medium scale computer at division artillery.

The computer requirement for mathematical computing in a division artillery then looks something like what is shown in Figure 12.

Data Processing Requirements

What are some of the Field Artillery applications in the data processing field? Many of the applications are straightforward, business accounting type problems, challenging because of their magnitude and because of the requirement to bring together the input from many sources. Other applications are less straightforward - or at least less obvious in their outline - and are therefore even more challenging to the artilleryman concerned with problem formulation and analysis. In the second group, there is particularly fire planning.

Fire Planning by Computer

The Artillery and Missile School has a program which can be placed on the commercial model computer at Fort Sill (a Bendix G-15D) to produce a schedule of non-nuclear fires at division
artillery level. For example, one problem we run plans the fires of 21 batteries against 97 targets in execution of a schedule of firing that occupies the batteries for one hour.

**Schedule of Fires**

This is a first bite into a larger problem. Fire planning includes much more than producing a fixed schedule of fires. However, the Artillery School's program works; it demonstrates that fire planning in terms of a fixed schedule of fires can be accomplished in a few minutes on a small tactical type computer. The implications are enormous. If the laborious process of fire planning can be reduced to an operation requiring on the order of ten minutes or less, the reaction time of large units can be drastically reduced. This may materially change the tactics of divisions and larger units.

When visitors to Fort Sill are first shown the fire planning program they frequently display certain incredulity. The objection is usually made that there is either some hocus-pocus about the operation or the results are poor indeed; for no machine can have the battle experience (and judgment derived therefrom) that we can expect from commanders and staff officers.

The objection is valid - to a point. However, it breaks down for two reasons. First, many of the operations in fire planning that we view as the exercise of judgment involve not judgment but routine response to a routine situation. And second, the machine can be made to accept human judgment in a number of ways: in establishing initial criteria; in modifying criteria in response to human direction when intermediate answers are presented to the operator for inspection; or through processes that, with a slight stretching of terms, can be called self education of the computer.

**Judgment in Fire Planning**

Consider the first point - that we often call the exercise of judgment what is in fact merely a standardised response to a standardised situation. For example, a fire plan to support a division Artillery non-nuclear schedule of fires is being prepared. The staff officer scheduling the fires and the available artillery formations has run down his target list and has come to a target labelled "machine gun". Map coordinates are listed, recent intelligence indicates the weapon is most probably wherenoted; the weapon is on high ground and in the general line of advance of the attacking force. The staff officer produces response A; that is, he schedules a certain caliber and volume of fire against the enemy weapon.

A moment later the staff officer comes to another item on the target list that meets the same general description. The planner again has response A. There may be a difference between the two enemy weapon positions; but by the time fire is planned this difference has left the intelligence picture. The difference may have been too subtle to permit reporting in the acceptably brief report procedures. It probably follows that the difference between the two weapons was also immaterial from a tactical point of view. The point is that the staff officer fire-planner has a standard reaction to a standard piece of intelligence. Much of fire scheduling is along these lines. Many officers drawing up schedules of fire have had only a general view of the terrain.

Admittedly, there is a quite a difference between a machine gun in the line of advance (or with a field of fire covering the line of advance) and a gun answering precisely the same description but located at a point too distant to permit it to fire on the attack element. But this is geometry and can readily be resolved by the machine.

The objection may be that the computer's reaction is too rigid, no room is permitted for variations in plan, situation, or the many imponderables of the battlefield. The answer is that more refinements will be built into our program as thought is given to them; and, perhaps more important, the program can permit modifications of criteria by the commander at any time. A particular enemy is particularly resistant to previously accepted standard quantities and types of fire. Very well, the commander directs that the standard reaction to a particular type of target be increased, doubled, or changed in degree in any way the battle experience and judgment of the commander or his staff suggest.

**Determining Who Should Hit**

The fire scheduling problem is composed of two phases. First, the machine must determine which units can hit which targets; then the machine must determine which units should hit which targets. Determining who CAN hit is straightforward mathematics. Locations of gun and target are compared, azimuths of fire are considered and a tabulation of the results stored. Considering one target at a time the machine examines each firing unit in the appropriate category that can hit that target and determines if the desired effect can be achieved by assigning the unit to fire on the target. Successively, acceptable units are assigned until the desired level of damage can be predicted. This is the who SHOULD hit phase. It presents the more subtle and interesting problem.

**Inputs:** "Target Word"; "Fire Unit Word"

To begin the problem we present the computer two sets of organized inputs - data with respect to the targets, known as the "target word"; and data with respect to the fire units, known as the "fire unit word." The commander's criteria are set in as constants and can be changed with each plan.
Target Word

The target word consists of ten pieces of data, as shown in Figure 13.

The concentration number is a tag that will permit identification of the target on the final fire plan. The tag will also permit deleting the target from the target list at any time prior to computing the fire plan. The coordinates are standard military map grid coordinates (a cartesian system) and form the basis for the determination of CAN hit lists by the computer.

The next seven items in the target word are what permit the blend of routine reaction and judgment (or commander's preference) in the machine developed plan. The seven items are all determining factors in the who SHOULD hit consideration. The final item, the date time group is necessary for intelligence processing.

Target Types

If there is to be a standardized reaction to targets there must be standardized targets. The working group at the Artillery and Missile School have developed a standard list of targets composed of three classes and, within these classes, a total of ten types. We consider that all non-nuclear targets presented to a ground force for planned fires can be categorized as falling within one of the types of targets shown in Figure 14.

Total Target Description

In addition to affixing a type number to each target it is assumed that the observer or other acquisition source will give some indication of the size of the target. An index of the magnitude can be conveyed under two convenient designators: scale, a measure of physical dimensions; and density, a measure of the number of personnel within the target area. Necessarily, both designators must be simple and stated in general terms. It has been tentatively decided to use two scales, and two densities. Scale 1 is a target, varying from a virtual point to approximately 120 meters in diameter; and scale 2 is a target of 120 to 240 meters in width, the depth remaining at 120 meters. The depths and widths are associated with the normal dispersion pattern from average battery gun positions for the calibers under consideration. Large target areas are attacked with conventional artillery only after they have been broken down into smaller targets of the scales mentioned.

With ten target types, 2 scales and 2 densities (density 1 is considered normal, density 2 a thickly packed target such as an assembly area) there is ample opportunity for adequate target description for immediate response to requests, and for intelligence file purposes. Ten target descriptions - more than ample.

Reliability is a reflection of the assurance that the target is in fact as reported. Targets are "confirmed" or "suspect".

Priority, Phase and Repeat

Priority has been established as 1, 2, or 3 for the machine. Priority 1 targets are those that must be hit or the fire plan is considered unacceptable and the machine halts, awaiting new instructions. Before halting, the machine attempts to shift the center line on which the battalions and batteries are laid to see if a slight change will increase the unit's capabilities. Priority 3 targets are those that can be most readily discarded. This leaves, by forced definition, priority 2 targets as those that should be hit if possible, and should not be discarded until after priority 3 targets are discarded. Priority can be determined by the computer from the other parameters. There is provision for override so that the local situation and the commander's desires may govern.

The remaining two items in the target word determine whether the target is fired on early, late, or in the middle of the schedule of fires; and whether or not fire is repeated on the target. Each target is tagged with the desired action as it is entered into the machine. If the commander wishes to make it a matter of standard procedure that certain types of targets are always fired on in a certain phase of the fire plan, this can be built into the program. The time required to input target data will be reduced accordingly.

The same applies to the repeat requirement. Fire can be repeated once, twice, or, in long plans, three times.

Fire Unit Word

It is also necessary to furnish the computer data on the fire units. The "fire unit word" consists of six parts. I shall not discuss them in detail as the purpose of each piece of data is fairly obvious. The fire unit word is shown in Figure 15.

Supporting the Fire Plan Formulator

The Fire Plan Formulator, the name given our program, modified and revised as it will be at the Artillery and Missile School, will produce a fire plan in less than a quarter of an hour - perhaps in as little as 5 minutes on a small high speed tactical machine. The Fire Plan Formulator needs to be supported by devices and procedures that work together as a system to provide an updated target list from which fire plans can be made on call. The Formulator also needs the support of devices and procedures that will take a finished fire plan and disseminate it to the many points on the battlefield where it will be used.

Such an integrated scheme of devices and procedures is in prospect for the Artillery. It is part of the Army's Automatic Data Processing System. The Army's effort to develop an automa-
tic data system for the field army (ADPS) is being especially directed toward the Field Artillery subsystem which will be first subsystem developed.

**The Artillery Subsystem for ADPS**

The U. S. Army Electronic Proving Ground, Fort Huachuca, Arizona is responsible for executing the analysis and programming of the full ADP system. The Field Artillery is actively supporting development of the Artillery subsystem.

In Figure 16 I have shown part of the Artillery subsystem up through division artillery as it may appear when allocations of computers are ultimately determined. Recall that a division is a body of men in the 10,000 to 15,000 class. The Division Artillery consists of six battalions and a Division Artillery Headquarters. A possible computer system for one battalion and the division Artillery is shown in Figure 16.

Note again our familiar forward observer, the battalion fire direction center, and the firing batteries in which are located the guns; notice the survey computer; and the division Artillery computer.

To perform the fire data computation (ballistic solution) which was discussed in the beginning of the paper we have the computer in the battalion - here. We also plan computers for fire control at the batteries. But now we have discussed fire planning and we have implied other applications, ammunition accounting, target list updating, survey, and others. The central processor (computer) at battalion must be fortified.

We will probably require memory increments or augmentation in some form to raise the capacity of the memory to 8 or possibly 12,000 words. In the forward areas such as battalion we do not believe that we can ever work with the fragility inherent in magnetic tape drives as we now know them. Memory augmentation might be through the use of special ruggedized canisters carrying endless loop magnetic tapes; or possibly the time requirement for program change will be sufficiently generous to permit the use of endless loop paper tape canisters.

We have under development for the ADP system, small core memory computers (known as COMPAC) which have a capability for the addition of memory modules in units of 4096 words at a time. This may be an unnecessarily costly means of memory augmentation for us. Just what computers and peripheral equipment will be used in the small units cannot be stated with any certainty at this time.

There is one interesting feature that we have introduced here and that is the multiple console concept. Around a single central processor (core memory, parallel computer) we have three consoles, or operating panels. The panels are labelled with the precise problem parameters of "fire control", "operations", and "survey" so that our soldier computer operators can be skilled artillery men first, and computer operators second. We cannot afford long periods of training for computer operators. A real time interrupt feature on COMPAC permits apparent multiple entry to the computer.

At the division artillery we have a medium scale computer known as the BASICPAC. This computer has a core memory of 4096 words which is readily expandable by the addition of memory modules of 4096 each. In addition to the 4 to 8 standard magnetic tapes available to it, the machine will handle half a dozen input/output devices. The computer is further fortified and brought to the medium class by the numerous index and real time registers.

**A Complete System**

Here we begin to have the heart of a true, relatively full computer system. The division artillery computer can query and respond to queries of the six battalion computers and to the survey computer working directly out of the Division Artillery Headquarters. The division artillery computer receives data for computation from the met station, or it receives for retransmission a met message computed at the met station. Our system now gives us survey, and meteorology - the full set of mathematical requirements less fire control which is accomplished at lower levels. The BASICPAC also gives us a capability for fire planning, target list processing, intelligence functions, ammunition accounting, march planning, and numerous administrative and logistical functions.

We now begin to look like part of a system. BASICPAC communicates with the Division Headquarters, with each of its own six battalions, and with the next higher Artillery Headquarters (known as Corps Artillery). Unquestionably, the system will give us great power.

As you can see, we in the Artillery have our work cut out for us in keeping one jump ahead of the hardware, in analysing our problems, and in planning the integration of the data handling of each problem into our system. We understand and appreciate the power of this great new weapon. It is up to us to do some hard thinking and produce the best possible methods for using it. We intend to try.
Among the combat arms
—Infantry, Armor, and Artillery—the Artillery holds a unique place with respect to automatic digital computing. The Artillery stands at that point in the field army at which technical mathematical computing meets automatic data processing—the instrument of logistics, battlefield management, and command.

Figure 1

NEED MATHEMATICAL COMPUTING FOR—

SURVEY (Where are we?)

METEOROLOGY (How strong is the wind?)

FIRING DATA (At what angle shall we point our cannon and rockets?)

Figure 2
Figure 3

Figure 4

Figure 5
COMPUTERS IN FIRE CONTROL

Figure 9

COMPUTERS IN FIRE CONTROL

Figure 10

From the collection of the Computer History Museum (www.computerhistory.org)
COMPUTERS IN FIRE CONTROL

Figure 11

From the collection of the Computer History Museum (www.computerhistory.org)
TARGET WORD

1. CONCENTRATION NUMBER
2. COORDINATES
3. TYPE
4. SCALE
5. DENSITY
6. RELIABILITY
7. PRIORITY
8. PHASE
9. REPEAT
10. DATE/TIME
## TARGETS

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<td>1. OP IN OPEN</td>
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<td>II - PERSONNEL IN SHELTER</td>
<td>2. INFANTRY DUG IN</td>
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<td>3. COMMAND POSTS</td>
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<td>5. OP DUG IN</td>
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<td>III - PERSONNEL/MATERIEL</td>
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<td>7. ARTILLERY</td>
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<td>8. ARMOR</td>
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Figure 14

## FIRE UNIT WORD

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Figure 15