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PROGRESS REPORT NUMBER NINE OF THE GADGET PHYSICS DIVISION OF THE LOS ALAMOS PROJECT

APRIL 15, 1945

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PROGRESS REPORT [illegible] OF THE GADGET PHYSICS

DIVISION OF THE LOS ALAMOS PROJECT

APRIL 15, 1945

The directive of the Division has been extended to include further responsibilities in design and procurement of the tamper assembly. In order to carry out these functions and to prepare for the assembly of the active material and [illegible] for the Trinity test and possible later shots, Holloway and Morrison of Group G-1 have been appointed Project Engineers for the implosion gadget to represent the Division.

The first critical assembly of 25 enriched metal in a WC and Fe tamper w made by Group G-1 on April 13. A pseudo-sphere containing 25.2 kg of β-stage met was constructed from 0.5" rods and cubes. This was surrounded by approximately 4 of WC and 6" of Fe. A critical condition was reached before all of the Fe on top had been added. Since in a previous assembly 24.7 kg had not been critical, it wa estimated that the critical mass of this assembly is 24.9 kg of U with concentrati of 78 percent 25. The over-all density was 17.7 g/cm^3 and the WC tamper density [illegible] A very rough measurement of pseudo-cylinders of various heights and diameters indi cates that for the equilateral cylinder the critical mass is 2 percent greater, wh for one with d/h = 1.6 there is a 3 percent increase, and for h/d = 1.6 there is a 6 percent increase over the pseudo-sphere. A further very rough and preliminary measurement indicates that 29 kg of this material stacked in the form of a pseudo-cylinder can be assembled without reaching criticality in a mock-up of the gun ta This assembly, however, is of slightly greater diameter and lower density than th anticipated target which, however, is expected to contain somewhat less material.

The first critical assembly of plutonium was made on April 21. Increas amounts of the + 4 plutonium nitrate in nitric acid contained in a double flask w immersed in a large water tank. In this condition, a critical condition was not

[redacted]

reached, but an extrapolation indicates something less than 600 gms for the critical mass of Pu. The correction for nitrogen and for the space surrounding the Pu [illegible] is considerable, and the estimated critical mass at a concentration of approximately 40 gms Pu per leader is estimated to be near 800 gms. The assembly was run still [illegible] supercritical by placing BeO blocks in the neighborhood of the active material.

Some further x-ray photographs have been obtained by Group G-2 in the [illegible] of spall jets. Introduction of a 2" baronal pad has been found to decrease the [illegible] effect, but was also found to decrease considerably the velocity of the plate producing the spall.

Nearly all of the efforts of the photographic x-ray work have been devoted to the study of the mechanisms employed in development of initiators, and some considerable terminal observations have been made as well.

[redacted] Be of this shape was coated with gold to be easily observed by the flash x-rays. Under the shocks used, there seems to be a squeezing action which does not seem to thin the gold covering. Photographic x-ray observations have also been made on the ejection of plugs of Be and their velocity measured.

Some experiments have also been carried out to obtain some information on the possible distribution of earth after the Trinity shot. The results here seem to be dependent upon whether the earth has been wet or not, and only under this

condition is any agreement obtained with the theoretical expectations of Penney.

Work on the development of x-ray tubes is being discontinued except insofar as this work can be made to be an immediate contribution to x-ray photographic program.

The development of pulse loops has been continued by Group J-3 and some further static and dynamic observations made.

Magnetic records of the usual type were also obtained. The pulse loop signal is well-defined, and the records of the 2 shots are reasonably consistent, but these records must be regarded as exploratory work. Further shots of this type using lens assemblies will be carried out soon.

A small scale experiment has been carried out to ascertain whether a charge with segmented metallic cover with the various segments insulated from each other could give a magnetic record from the contained sphere. The record was completely illegible, and it is concluded as expected that a magnetic record at Trinity can probably be obtained only if the outer metallic case is replaced.

Considerable work has been carried out by Creutz' section in Pajarito Canyon in unraveling the records always obtained from the high explosive prior to collapse. It seems that this section of the record is surprisingly regular and can be correlated, both in solid charges and in lens assemblies, with the interaction of the detonation waves from the various points of initiation.

The time of the appearance at the outside of the reflection of the shock from the Tu and also from the center seem to agree quite well with expectations. In order to make some analysis of the compression of the Tu, a further shot

Considerable work has been done by Group J-4 in the production of receiving setups for detonator informers. This has proved to be a long and difficult job but three complete receiving setups have now been made and have been tested both here and in the field. Much of the effort of Group J-4 has in the past month been spent in this work and in the development of electronic gear for the Trinity test. Equipment for use at other field sites away from Y is beginning to take a considerable effort on the part of the group.

A collapse curve in the neighborhood of the expected minimum radius has been obtained. Using all data which are summarized in the group report, the points show a considerable spread. However, these data contain multipoint detonations and a number of reject lens assemblies. When these latter points are extracted, there is but one discrepancy, and this quite a bad one, on the collapse curve. The origin of the large discrepancy for this single observation is not known.

Insufficient data have so far been obtained to ascertain the spread in experimental results and to detect with certainty any fluctuations in the perfection of the implosion.

These experiments indicate that reasonably good results can be expected on this larger scale, although the first picture obtained was quite weak.

Considerable technical improvement has been obtained in both the cloud chamber and the betatron. The intensity of the betatron has been raised about 50 percent by contracting the orbits soon after injection. A new cloud chamber with magnetic field coils has been put in operation with some difficulties, and improved results have been obtained.

A number of changes had been made from previous experiments, and, unfortunately, very strong electromagnetic disturbances made the record useless.

These results on U and Cd are probably subject to considerable error due to the necessary corrections. It is, nevertheless, quite encouraging to find that the observed compression for Tu is approximately that expected and indeed bears the

[redacted]

[redacted]

same ratio to the theoretical value as that for Cd.

The experiments now being carried out in the Ra La program all demand sources of much greater strength than originally anticipated in the work with thin shells. This has always strained the production and chemical separation facilities to the utmost. In an effort to help somewhat with these difficulties, chambers of greater length have been developed, and it is hoped to employ these in the shots where the greatest intensity is demanded.

Group G-7 is now supplying detonators to most of the field sites which are firing large charges. The detonators now supplied are CIT loaded platinum bridge wire detonators (Type 1-E3).

Double detonators of an interim design have been used at Bayo Canyon in order to preclude failure. This design, however, appears on fragmentary evidence to give a greater time spread than is observed from the single detonators.

Type 1-E3. No significant results have yet been obtained with these detonators.

From preliminary tests on the 1-E3 detonator, it is anticipated that vibration and high humidity can easily be tolerated by the detonator. Deleterious effects, however, have been observed from storage at 60°C. Further tests are being

[redacted]

carried out at this and lower temperatures, but some restrictions may need to be placed on the temperatures allowed for PETN field detonators. Because of the uncertain temperature effects, and because of the rather low safety factors with the Raytheon firing unit, work has been resumed on the lead azide spark detonators. Contrary to previous opinion, the lead azide under high pressure seems to be no more sensitive than the PETN.

Numerous hemispheres with lens assemblies have been shot in the past month by Group G-8.

In the latter case, however, the photographic work of Koski gives definite indications of jets. This velocity is in extraordinarily good agreement with that calculated by the theorists.

In this case, two shots have been made and evidence found that while the velocity is the same at the edge of a lens and under the center, in one case the intersection was 0.7 μsec late and in the other 1.0 μsec early relative to a point under the center of the lens. These shots were carried out with second quality lenses, but a similar shot was first quality lenses fired after the group report was written shows a similar effect.

Experiments have been continued to determine the shock velocity in aluminum, cadmium, lead, steel, and tuballoy, as well as the initial material velocities. Some variation in the results has been found from small changes in the detonating system, and these discrepancies are being further investigated.

Various measurements of initial velocities of surfaces have been made for use in the initiator work. These have been needed to get some idea of the violence of shock in the various implosion tests. Measurements have also been made to study the ejection of Be plugs from flat steel plates. It is found that the plugs are ejected at 2200 M/sec compared to a velocity of 1400 M/sec under these conditions for the steel plate. The Be is found to move ahead of the steel by a time which depends upon the shape of the Be plug.

These observations are preliminary, but are of considerable promise in the study of initiators under conditions of high shock.

The development and critical examination of modulated initiators has been continued by Group G-10. With direct proof of a modulated initiator almost impossible to obtain except in the firing of an actual gadget, efforts have been concentrated on carrying out partial proofs and studies of mechanisms as near the final conditions as possible.

With the melonseed (or Serduke type) initiator, the mechanism has been studied in some detail with x-rays and velocity measurements. Furthermore, the melonseeds have been observed to act in the predicted manner in implosion shots.

The first experiment has been carried out to examine the emission of neutrons down to a few milliseconds after assembly. This has been observed in a gun shot with Nicodemus type initiators, and no evidence for change in efficiency observed from a few milliseconds on. It is hoped in the future to test other types of initiators either by gun assembly or, in the case of jets, by sheet jets produced by the Munroe effect and found to carry the measurements to somewhat shorter time intervals. In the case of the jet effects, it is also planned to carry the observation of alpha particle on the jet to the microsecond times. The observations in the millisecond intervals should eliminate at least some of the secondary effects which it had been suspected might give rise to the high efficiencies in observations of hot shots.

Similarly, work on the shells type initiator has been dropped except insofar as study might aid in one of the initiator types described above.

It seems likely, but not certain, that a successful modulated initiator either of the jet (Urchin), melon seed (Gerdine), or Nicodemus type can be constructed. On the first two types, the tests can be carried considerably closer to the conditions actually expected in a gadget.

Most of the efforts of Group G-11 have been devoted to preparations for the optical observations on the Trinity test. Most of the photographic equipment will be in operation for a 100 ton shot in early May. A few additional photographic observations have been requested and are now being prepared, but the greater part of the instrumentation is complete although a considerable amount of installation work still needs to be done.

The group continues to provide special photographic service, and recently the requirements for developing special motion picture film have considerably increased. Some further improvements have been made in the optical instrumentation for some of the field work at Site Y, but this has recently been a small part of the efforts of the group.

R. F. Bacher

GROUP J-1 - O. R. Frisch, Group Leader

April 23, 1945

The appointment of M.D. Holloway and P. Morrison as project engineers for J Division necessitated some change within J-1. C.P. Baker was made deputy group leader, and B.T. Feld took over from him the responsibility for problems of nuclear safety. L. Slotin will be in charge of all 49 work, and C.P. Baker of all 25 work.

2. Safety Tests at Omega - C. P. Baker, H.K. Daghlian, J. Kupferberg

No tests this month.

3. Safety Tests Outside Omega - C. P. Baker, H. K. Daghlian, J. Kupferberg

None requested this month. Apparatus is available.

4. Pohi -

Shelved.

7. Feynman Experiment -

No further work will be done unless the time scale measurements give unexpected results and thus indicate the need for more information.

8. Rossi and F. M. Experiments -

Will be started in R-1 in a day or two.

11. Delayed Neutrons -

The measurements by de Hoffman et al. mentioned in the last monthly report have been reported in LA-252.

12. Critical Sizes of 25 Metal Assemblies - Group

A self-supporting chain reaction in 25.2 kg of β-stage material in 4.5" of WC, surrounded by six inches of Fe was obtained on April 15. The critical mass was found as $24.9 \pm .1$ kg. This corresponds to an average of 78 percent of 25, a stacking density of 17.7 and a tamper density of 14.73, and hence means that the standard crit is 14.3 kg.

13. Neutron Distribution in Reacting 25 Metal Assembly - A. Comac, B. T. Feld, W. Hughes, F. Morrison, J. P. Baker

The distribution along a radius was measured with 25, 28, and 37 chambers which had been supplied by H-5 who also gave help with the measurements. Activation of 25 and 28 foils confirmed the results of the chamber measurements. The data have not yet been completely analyzed.

14. Power Calibration in Reacting 25 Metal Assembly -

Shelved.

15. Gun Model Tests - J. Bistline

Equipment is ready for tests to be started as soon as enough material is on hand.

16. Critical Mass of 49 in Solution - Group, with the help of C. Garner and D. Carritt of CM-5.

A solution of 495 gms. of Pu (as plutonium (+ 4) nitrate) in 11.6 ltrs. of 1-molar nitric acid surrounded by water was not quite critical but became so when the container was surrounded by 1" of BeO (in the water). Measurements with various amounts and concentrations were made. Extrapolation indicates 575 ± 30 gms. 49 as the critical mass if dissolved as described above. If no nitrogen were present and no container walls etc., the critical mass would be somewhat below 500 gms. A report is being prepared.

17. Instrumentation for Field Testing of Nuclear Components - O. R. Frisch

In discussions with Langer, Higinbotham, Helmholz, it was agreed that proportional counters with B^{10} lining should be developed without, however, dropping the development of $B^{10}F_3$ filled counters now under way in CM. It is hoped that the lined counters can be made in Chicago. An attempt made in G-1 to make thin B layer

by sedimentation from an aqueous suspension looks hopeful, and this method may be a usable alternative to the diborane method if needed. These counters are to be used in an instrument, developed in J-4, for testing gun initiators.

Tests are under way to determine the sensitivity of a B^{10} - lined electroscope of the Chicago type as a neutron detector. It will probably be sufficiently sensitive for testing P. M. initiators and checking the multiplication rate of the gadget in various states of assembly. For the gun initiators, it will not be sensitive enough. On the other hand, it is simpler and perhaps less apt to fail than the more sensitive electronic equipment.

GROUP 3-3 - L. P. Parratt, Group Leader

April 20, 1945

1. X-Ray Photographs - Duck(in charge), T/4 Adler and T/5 Mayers

1.1 Spalls. On account of the higher priority of the initiator problem, spalls have only briefly been studied. The main point was to examine the effect of replacing a 2" layer of the Comp. B in a normal slab shot by a 2" Baronal pad. Photographs were taken with values of α of 25° and 3°. (α is half the angle subtended by the boosters at the plate).

a) For 25°, the jet spall was reduced in magnitude by a factor of 2 or 3; for 3° , no jet could be distinguished.

b) The spalling was greatly reduced, i.e., a possible single spall lamina could be faintly distinguished.

c) The plate velocity was approximately halved.

1.2 Jet Initiators. The penetration into steel of shock operated jets from a 1/4" copper plate, the depth of the Munroe cavities being in all cases 1/8", has been measured for cone angles 0°, 45° and 90°. All give jets, with 45° giving the greatest penetration.

[redacted]

The penetration has been found to scale accurately for cavities reduced from the usual 1/8" depth, down to a depth of only 1/34".

Experiments have also been made to detect and measure the penetration of shock operated jets in beryllium. Cavities 1/8" deep, of included angle 0° and 45°, in 1/4" beryllium were excited by the usual 1-1/2" diameter 6" long pentolite cylinder. Jets were obtained from both cavities, the penetration from the 45° jet into beryllium being the greater, thus paralleling the behavior of copper. The 45° jet at 1/4" range penetrated 8 mm.

Shock operated jets have now been observed with the following materials: paraffin wax, lead, copper and beryllium.

In collaboration with Group G-10, a jet of Be from a 45° cone penetrating into steel, has been detected, excited at the center of a 3" screwball. This will presumably be more fully reported in the report of Group G-10.

In preparation for the experiment of measuring the neutron efficiency attained when a Po jet from a true Munroe charge is fired through a diaphragm into a beryllium block, a cold experiment has been made in which a jet was successfully fired through a 2-mm hole in a steel diaphragm, subsequently penetrating more than 1/2" of cast Be.

1.3 Urchin Initiators.

[redacted]

2. X-Ray Photographs - D.P. MacMillan (in charge), A. Wilcox

2.1 Grape-nuts Initiators.

A photograph, taken twenty microseconds after the shock wave had struck the upper surface of the beryllium, is shown as Fig. 7. A rough measurement gave for the velocity of steel 512 meters/sec and for the beryllium 1510 meters/sec. The ratio of velocities is 4.8, whereas the ratio of densities of steel and beryllium is 4.3.

The beryllium can be seen satisfactorily, and it is planned to make many shots using beryllium plugs of various shapes and a steel pusher plate. These shots are awaiting delivery of plane lenses of H.E.

3.3 Earth Absorption Experiments. It was suggested by Mr. Penney that the earth thrown into the air by an explosion may be sufficient in quantity to interfere seriously with, if not preclude entirely, certain measurements which are being planned at Trinity. Tests of such earth quantities are being made with x-rays. A small quantity of explosive is detonated at scaled height above earth, x-rays are flashed at the desired time and the transmitted x-ray intensity recorded on an 8 x 10 inch film.

The first experiments were planned for a 1-ounce charge of Composition B in the form of a sphere with the booster in the center of the charge. The scale factor for a 1-ounce charge is $\left(\frac{5000 \text{ tons}}{1 \text{ oz}}\right)^{1/3} = 540$. Thus, the center of the charge was located 2.2 inches above the surface of the ground and, since predicted crater size is 240 ft. diameter and 50 ft. depth, the scaled predicted crater size is $\frac{240 \times 12}{540} = 5.3$ inches in diameter and $\frac{50 \times 12}{540} = 1.1$ inches in depth. 1-ounce charges were tried out on dry, loose, sifted earth and it was found that the surface was blown away without crater formation. However, when the earth were made moist and of jelly-like consistency a crater of the predicted size was formed.

It was decided to try half pound charges, i.e., scale factor 272. The results were substantially in agreement with those obtained using 1 oz. charges. X-ray pictures were made at times ranging from 385 microseconds to 1 millisecond. The shadow cast by earth could be seen two or two and a half inches in the air (approximately 45 feet on full scale).

Question was raised by Weisskopf, Marley and Penney regarding the faithfulness with which the behavior of earth at Trinity is reproduced by earth materials used at P-site. In order to establish a calibration of the earth, and to obtain a supply of Trinity earth for use at P-site, Crocker, MacMillan, White and Wilcox fired at Trinity a number of 8.4 oz. charges, some 42.6 oz. charges and some slightly

larger charges. It was found that the radius to which the blast affected the earth was approximately as expected from the scaling laws, but that under the impact of explosion the earth had a tendency to compress permanently into a substance like soft shale. This compression has been observed at P-site in the case of explosions over ground which has been thoroughly compacted into an homogeneous mass, and permitted to dry out almost completely.

To date, the following types of crater have been observed --

1) No crater at all is formed in dry dust and a scouring action simply blows away the surface layer of material.

2) In materials such as mud, which is wet enough to act like a plastic, a crater of the diameter predicted by the scaling law is made, although the depth of the crater is likely to be greater than predicted. The profile of the crater is approximately as shown in Fig. 8.

3) If the material is dried out enough to be highly compressible and if it has some strength, then the crater tends to have somewhat less than the predicted diameter but a profile which shows that the major effect has been one of compression. The profile is approximately as shown in Fig. 9. The crater shows, in general, only slight evidence of removal of matter. A more or less unpredictable amount of shattering of the compressed earth is usually observed in the bottom of the crater.

The desired conclusions as to the earth density in the air as functions of time and position have been sidetracked because of the sensitivity to the particular conditions of the earth.

3. X-Ray Equipment - Cuykendall(in charge), Finlayson, Mangsness, T/3 Schluter, T/4 Kilburg, T/4 Price

3.1 X-ray Tubes. As result of conference of interested parties it was decided

to terminate the development contract at Westinghouse April 1. The reasons, set forth in a memorandum from Parratt to Oppenheimer, dated March 22, are briefly: (a) low future priority of this x-ray method in the program at Site Y, (b) low immediate promise of adequate improvement in tube performance as result of Westinghouse development, and (c) the contract had run the time expected when it was set up.

Dr. Parratt of Site Y and Mr. Leitlin of the Manhattan District met with the Westinghouse representatives on April 10 and 11 to discuss final contractural arrangements. These arrangements, reported in the conference notes, include completion of 5 special tubes as follows: (a) One WL340-389 combination (hollow anode) with no ferrousmagnetic material, (b) Two Type 1125, pin point diodes, but with target-cathode distance adjustable over a wide range, and (c) Two Type 7005, radially symmetrical cathode structure. These last two tubes should permit final tests of the parallel focussing method. Shipment of all of these tubes from Westinghouse is expected in early April.

Four standard WL 389 and no experimental tubes were received from Westinghouse during the month. As of this date, a total of 72 standard tubes and 13 special experimental tubes have been received at Site Y. Twelve new unused tubes are on hand. Eight tubes, no longer serviceable, were returned to Westinghouse; a total of 20 in such condition have been returned since Project Y was established. Return of an additional 8 tubes, mostly ones which show internal sparkover, was held up because of stoppage of development work at Westinghouse.

The difficulties associated with the large diameter anode sleeve, described in last month's report, have continued and the explanation previously presented has been further confirmed. Punctures in the glass at the anode stem have occurred in f tubes.

3.3 Magnetic Focussing. Nine standard tubes were given 10 flashes each as a diode, and 10 additional flashes each as a triode with 7000 ohm trigger resistance. The effective width of focal spot, its general shape, the integrated intensity thru 3" dural, and effective wavelength (photographic step wedge) were observed for each flash. The results scatter as is expected from the statistical nature of the tube performance, but the trend discussed in last month's report is further confirmed, i.e., the presence of the magnetic field causes in general a severe reduction in integrated intensity. From this survey it is possible to choose three tubes having marked reduction in focal spot size, and integrated intensity adequate for study of the initiator action at P-site.

Experiments are under way to investigate the mechanism by which the presence of the magnetic field reduces the integrated x-ray intensity. The tube current, the x-ray pulse shape, and the integrated intensity thru 1/8" steel and thru 1/4" lead will be observed simultaneously for flashes with and without applied magnetic field.

A new oil container for the x-ray tube has been built and installed in the P-site wart. A magnetic focussing coil and pulsing equipment to synchronize with detonation of explosive are being installed.

3.4 Surge Generators and Timers. A 10 KV driver for the 285AW pulse transformer has been designed, built and tested. The auxiliary surge generator for pulsing the cathode has been built. The timing circuits are now being tested.

Successful oscillograms of the current pulse in the surge generator have been obtained from a balanced line and non-inductive resistors between the ground sections of surge generator condensers. Pickup has been entirely eliminated and the equipment is ready for routine use. Superimposed on the 500 KC oscillation is a very high frequency component (about 20 megacycles) which has been proven to be a secondary oscillation thru stray capacity to ground of generator elements.

3.3 Ion Chamber Monitors for X-ray Intensity. After modification of the circuit and shielding, the integrating ion chambers are now working satisfactorily. The sweep circuit for the pulse shape equipment has been redesigned and is now ready for test.

4. General Facilities at P-Site - Crocker(in charge),T/3 Ritner, T/4 Whitworth White, Garn

The volume of charges fired at P-site has been reduced this month. This stems from the change in emphasis in Tuck's work to initiator shots. A considerable effort on the part of the P-site crew has been necessary to get MacMillan's program rolling.

Changes in personnel include the addition of T/4 Whitworth, who becomes the Assistant Field Manager at P-site.

The photographic facilities are over-crowded and our photographer has asked for an enlargement of the darkroom. This appears to be possible without too much expense by walling off the area now used as office space in Bldg. no. 1.

The magazine has been emptied of all surplus castings except the 2S60-100's ordered for the counter program. Marley has been informed that we have 24 of these castings and he is trying to find some good use for them.

The crane was received from C Shop and functions nicely on level ground. Some improvements which we propose to make outselves will make it useful on ground that is not level. MacMillan's earth experiments would be difficult without the use of the crane. K-site has also borrowed it on two occasions.

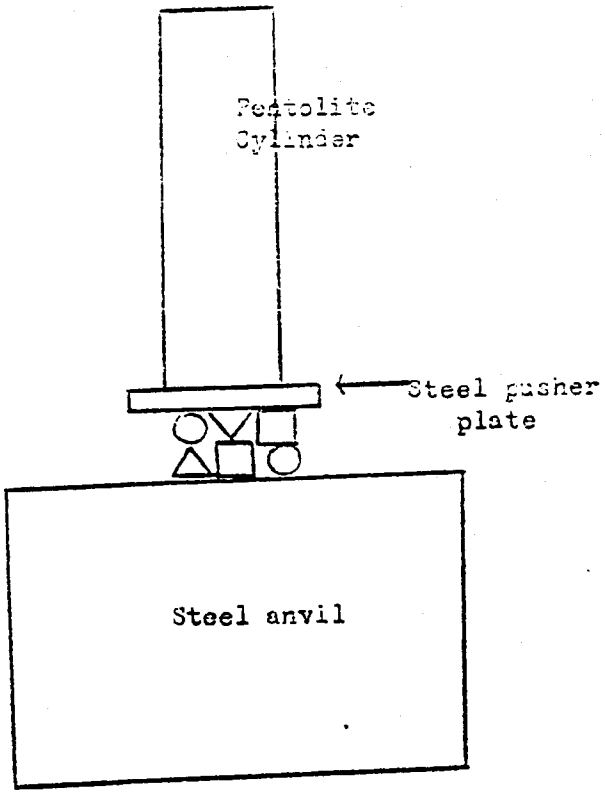

Fig. 1

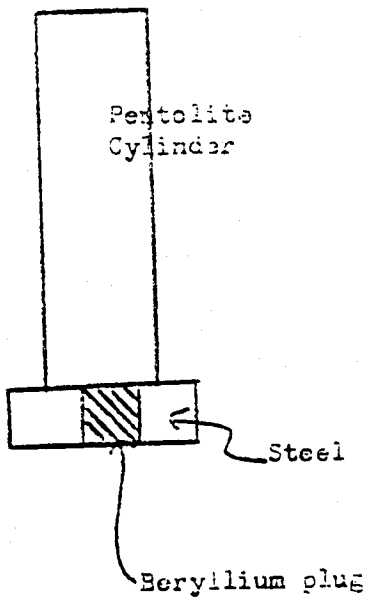

Fig. 6

Fig. 8

Fig. 9

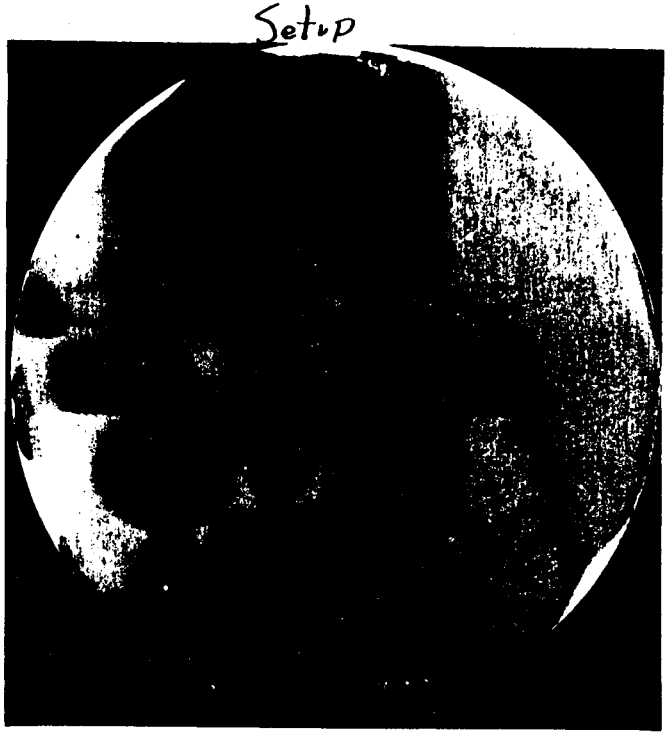

Figure 2

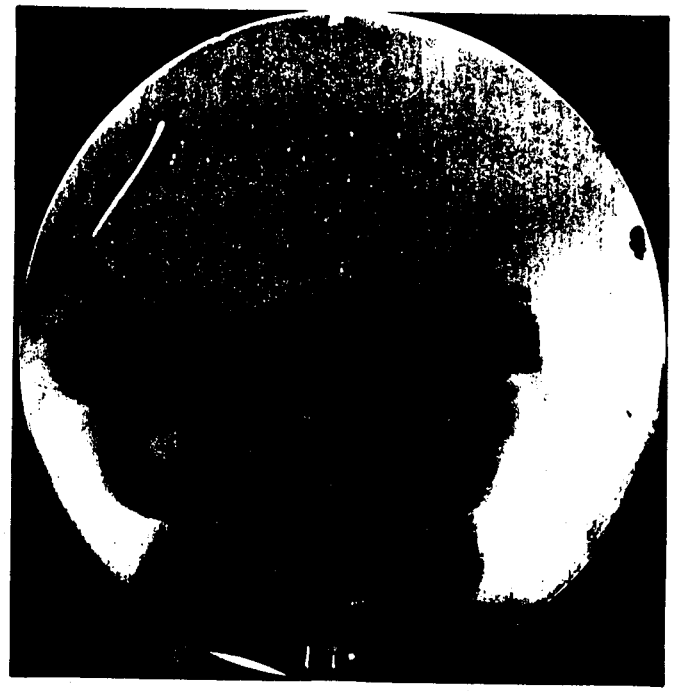

Figure 3
Picture taken 8 μs after shock struck upper surface of steel pusher

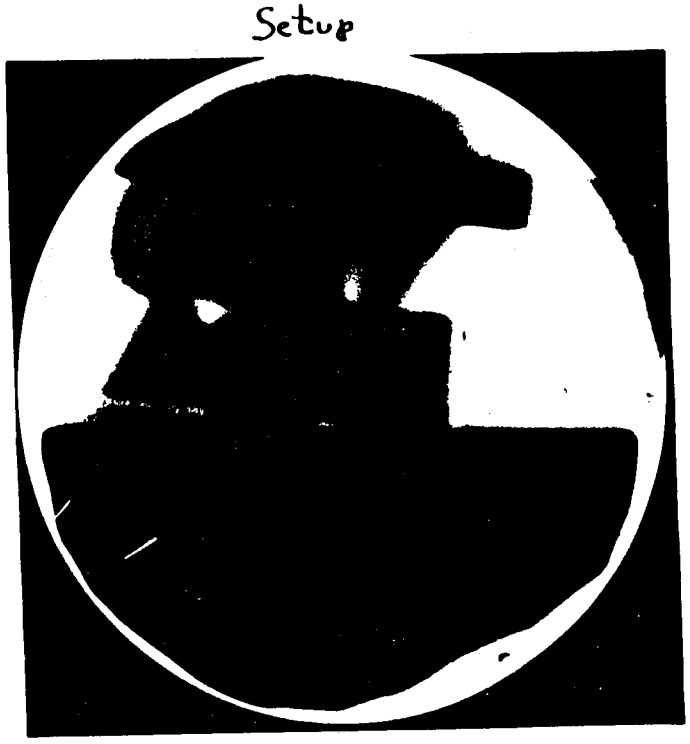

Figure 4

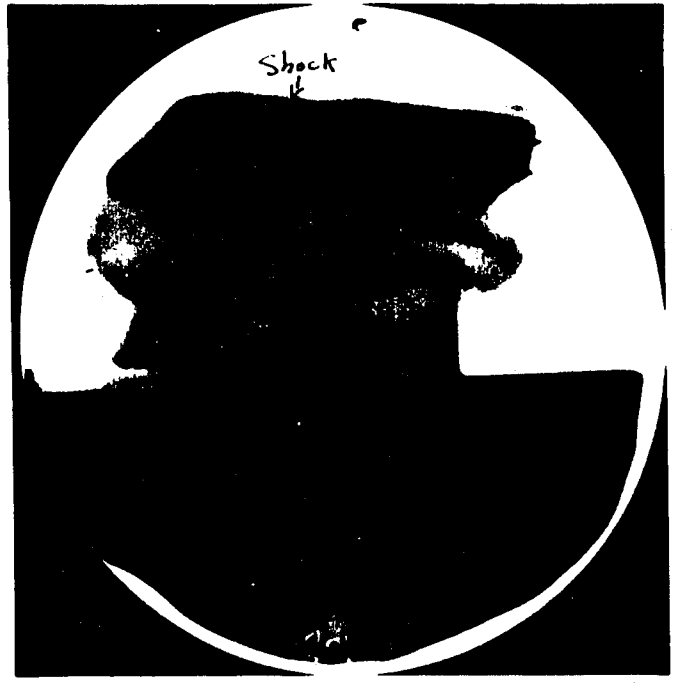

Figure 5
Picture taken 12 μs after shock struck upper surface of steel pusher.

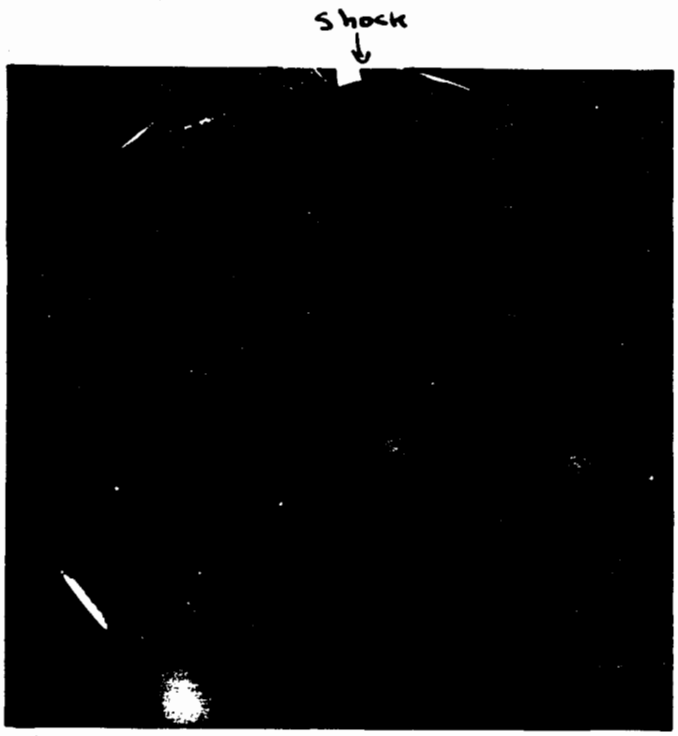

Figure 7

Picture taken at 20 μs after impact of shock on upper surface of steel pusher

GROUP G-1, E. M. McMillan, Group Leader

April 26, 1945

Personnel: Section 1 - Clancy, Daly, Fowler, Miller, Rosen and Thompson

Section 2 - Aboyte, Chavez, Creutz, Davisson, Feder, Foss, Frankel, Fuller, Guttchen, Hershey, Hobday, Klein, Kratz, Lanahan, Major, Nichols, Peterson, Shank, Stark, VanBeneden, Wonner and Young.

SECTION I.

I. Instrumentation. All.

A. New Apparatus. Pickup coils and I.F. amplifier (B. McDaniel) being assembled for pulse-loop studies at high frequencies ($\sim$ 20 megacycles). The detection of high frequencies will permit higher pulse signal amplitude.

B. All records analyzed for HE background. For Comp. B, the field insensitive background in equivalent time rate of change of dipole moment is equal to 0.3 W (lbs.) x 10^6 EMU per sec. in the range of 0-30 lbs. For details, see LA-250.

II. HE Attenuation and conductivity. Rosen and Fowler.

A. Attenuation experiment discussed in LA-250.

B. A series of simplified experiments on magnetic field sensitive background indicate that this may be a surface effect. (See LA-250).

VII. Exploration Shots. Rosen.

A test was made on the possibility of obtaining a magnetic record at Trinity, if dural case is used to contain charge.

The magnesium case was segmented in the same way as the full scale dural case prepa

for the Trinity test. The segments were electrically insulated from each other by 1/8" textolite and held against the charge with tape. In the case of the first charge, fired in a magnetic field of 42.6 gauss, a negative signal begins at the time the case starts moving and blocks the amplifier. For the second shot, a signal limitor was incorporated in the amplifier. The magnetic field in this case was 45.1 gauss and the record shows that the signal from the exploding magnesium shell obscures the implosion record.

It appears from these shots that, if a magnetic record is desired at Trinity, one should plan on using a plastic case.

X. Pulse-loop Circuits. Thompson and Fowler.

A. The impedances of several types of pin contacts and jet contacts (two sheets Cu separated by Scotch tape) have been shown to be quite low ($< 0.03\,\Omega$).

B. Work is progressing on the design of small generators.

XI. Static Tamper Attenuation Measurement of Pulse-loop Signals. Thompson.

XII. Pulse-loop Studies of Implosions. Thompson and Fowler.

The usual magnetic record and one pulse-loop signal were simultaneously obtained. The results are summarized in the two time scales shown below:

[redacted] DOE b/3 [redacted]

The internal consistency of the two records is probably as good as can be expected with primacord detonation.

[redacted]

[redacted]

DOE (b)(3)

[redacted] A two-pulse generator was mounted at the center of the Al sphere with a jet contact 0.86 cm from the inner surface directly under the pole, and a pin contact the same distance from the inner surface of the opposite hemisphere at a point where jets are not expected to occur. A simultaneous magnetic record was also obtained. The record of the loop signals was consistent with that from the exterior surface and indicates no pole jet appeared at a time 9.4 μsec, after the beginning of the implosion. This is, of course, a preliminary result.

SECTION 2.

I. Summary. Magnetic field sensitive signals from the detonating HE which so far have not been eliminated are probably consistent enough so that corrections can be made for them to obtain good values for compression. [redacted] Plans are continued on full-scale shots at Fajarito.

DOE (b)(3)

II. Background Due to High Explosive. The signal picked up by the magnetic method due to the detonation of the HE is now known to consist of 3 parts. There is electrostatic hash which is effectively eliminated by shielding the pickup coil and which, in any case, is not particularly troublesome since it does not increase in magnitude with charge size. The magnetic hash, which cannot be shielded against, increases approximately with the weight of the charge. However, since it is not dependent on the external magnetic field while the signal from the metal sphere is, trouble from this hash may be made negligible, probably even on full-scale shots, with magnetic fields of the order of 600 gauss. A third type of background is proportional to the magnetic field and to the square of the charge diameter in the same [redacted]

[redacted]

way that the signal from the metal sphere has. It, therefore, cannot be eliminated by any method known at present and must be carefully studied in order that corrections may be made for it if accurate values of the compressions of metal spheres are to be obtained.

This field sensitive disturbance consists of a gradual negative dip in the voltage record starting as the charge is detonated. A very steep positive spike occurs at the time when detonation waves from neighboring boosters interact along the chord of the sphere between them. A second similar spike occurs at about the time when detonation waves from 2 neighboring points meet at a point on the surface of the sphere equidistant from them. Actually, the time for this spike is such that the velocity of the waves, if they follow the path suggested, is about 3 percent less than that through the body of the charge. This is, perhaps, not surprising since they are travelling so near a free surface.

[redacted]

Although it is not usually resolved as a separate spike, it occurs at the time when 3 neighboring detonation points interact at the point equidistant from them in their plane. A fourth spike which is sometimes well resolved occurs at about the time when waves from 3 neighboring points meet at the point on the surface of the sphere equidistant from them. This time is again such that the detonation wave apparently travels with about 3 percent smaller velocity than that in the body of the charge. Other signals are received when the shock waves which are reflected from the multiple reaction points again reach the booster points.

The first spike is the most clearly resolved and the strongest.

[redacted]

We may say that the existence of at least two interaction spikes is definitely established, while the further resolution into four is probable but not certain.

These times, together with the time when the electric signal from the detonators is received, give very useful fiducial marks on the record. Counting as 'zero time' the detonation of the caps, the following times for events are calculated and observed as shown in Table I.

A similar set of interactions is observed with lenses as would be expected since the outer part of the lens charge is geometrically almost identical with the outer part of a non-lens charge. Again calling the time when the electric detonators are activated as 'zero time', the following events (Table II) were calculated and observed for 12L80B lens charges:

TABLE II (12L80B)

By the widths of the spikes and the times when they occur, a fairly good idea of simultaneity of detonation should be made possible.

Several experiments have been done in attempts to reduce the magnitude of these background signals.

believed to consist of better than 95 percent butane, no definite decrease in the height of these signals is found. When the charge is fired immersed in oil, there is some evidence that they are considerably cut down. Further experiments are required to determine the exact source of this background and to determine the possibility of reducing it. Since the sign of the spike signal is positive, it must correspond to an inward moving conductor or else to the sudden disappearance of a magnetic moment of the opposite sign.

We do not have as yet sufficient experimental data to decide between these hypotheses.

III. [redacted] This difference may partly be accounted for by the delay in initiation of the inner charge by the slow component of the lens. This was not included in the calculation. The time of emergence of the shock wave reflected in the Tu sphere is clearly shown as a steep drop on the record. [redacted]

A background shot with a similar lens system imploding a marble sphere was made. The detail in the high explosive background before the start of the implosion is very similar to that on the metal shot. It is believed, therefore, t

[redacted]

[redacted]

Marble spheres are being made

available for this purpose.

IV. Full-Scale Plans. Based on availability of charges, the date for the first full-scale shot at Pajarito has been changed to June 1. R. B. Henderson's group has agreed to take the responsibility for assembling the charge and cradle. Plasti cases to hold the charges together have been obtained. Helmholz coils furnishing about 1,000 gauss will be used. These will weigh about 1 ton each. The charge will be set up in a house which can be filled with butane if desirable. Fastax pictures will be taken from 3 directions and 3 magnetic records in mutually 1 planes wil be recorded.

[redacted]

[redacted]

GROUP G-4 - W. A. Higinbotham, Group Leader

April 15, 1945

In the period March 15 - April 15 about 130 pieces of equipment were delivered.

Much of the effort of the group, in this period was directed toward Trinity and Alberta. The equipment developed for these applications will be repor later.

MODEL 200 PULSER - SANDS

The Model 200 Pulser was designed and two were made for Group G-8. The pulser provides a pretrigger which is accurately adjustable in steps of 2 microsecc from zero to 10 microseconds before the signal pulse. The pre-trigger pulse is variable in amplitude. The signal pulse is a positive square pulse which has a ris time and a fall time of less than 0.1 microsecond. The height is continuously vari in amplitude to a maximum of 75 volts and is calibrated to 5 percent. Attenuated outputs are provided for levels down to 100 microvolts. The width of the signal pu is variable in steps of 2 microseconds from 2 to 10 microseconds.

INFORMER FOR X-5 -- SANDS

Three complete receiving setups have been made. One was installed in a carryall for tests at this site. Two have been installed in a trailer at Sandy Ses Each setup consists of:

1. A 60 megacycle receiver with a band width of 8 megacycles. These receivers were developed by the Radiation Laboratory for Radar use and with some mi modification have been made suitable for our purpose.

2. A sweep circuit which is triggered by the signal and a calibrator for introducing timing marks on the oscillograph.

3. A video amplifier and delay line. The incoming detected signal is used to trigger a sweep, is delayed, amplified, and presented on a six kilovolt cathode ray tube where it is photographed.

The resolving time of the whole receiving system is about 0.1 microsecond. Overall tests here and at S.B. have been made with transmitters on the ground, and airborne transmitters on land and water, with simulated signals and with explosive switch signals. All of the tests indicate satisfactory operation of the complete system.

Betatron Monitor - Elmore

The preamp contains a cathode follower, and a standard-1500 volt R.F. supply for use with an open air, parallel plate, transmission chamber. The main amplifier chassis contains a regulated power supply and two highly stable feed-back loops with a frequency response from 50 to 500 cycles. Output from first loop drive are external pulse lengthener for measurement of a single direct betatron pulse; the output from the second loop is coupled for an internal peak-to-peak reading VTVM which measures average Gamma-ray intensity (attenuated by a shutter) while betatron is cycled during adjustment.

Capacitance Bridge for Small Capacities - Kapplemann

T/3 George Kapplemann has constructed a self-contained substitution type capacity bridge capable of measuring small capacities to an accuracy of about 0.1 mmfd. when shunted by a resistance as low as 50K. This bridge is useful for measuring circuit capacities, particularly in fast amplifiers.

Model 300 Sweep Circuit - Elmore

A sweep generator with speeds as fast as 0.5 microsecond per inch for

use with 5UP scopes has been designed and a shop model constructed. It contains a conventional discriminator for the trigger, a sweep circuit similar to that of the Model 5 Synchroscope, and a univibrator clamp which prevents a second sweep from being triggered for a period of 5 seconds. This gives ample time for the camera shutter to be closed. The circuit contains a regulated power supply for the portion of the circuit not stabilized by feed-back.

GROUP G-5 - S. [illegible] Tiedermeyer, Group Leader

I. BETATRON

An improvement of approximately 50 percent in the betatron pulse output has been obtained by using a trick found by Adams at Illinois. The trick is essentially to make the orbits shrink more rapidly immediately after injection and the effect of this is supposedly to reduce the probability of electrons striking the injector in the early stages of acceleration.

Tests with 125 lb. cylinders indicated that the rubber shock mounts used for the betatron were inadequate protection for charges as big as 200 lb. New spring mounts were therefore installed, and tests with 200 lb. charges show that the provide completely adequate protection.

II. CLOUD CHAMBER

The new cloud chamber mount and magnet coils have been installed and are now in operation. The magnetic field produces some improvement in the image but no actual analyses have been made to give a quantitative comparison.

III. MAGNETIC WORK

The installation of equipment for use of the magnetic method has been completed by Nieneke and his group.

The metal charge supports, which were the worst source of hash, have been replaced wood and bakelite supports. Several records have been made from which useful times may be obtained but no significant results can yet be given.

IV. EXPERIMENTAL RESULTS

DOE b(3)

DATA SHEETS

CHARLES BRUNING COMPANY, INC.

[redacted]

The points seem to scatter rather badly, but referring to the "Remarks" column in the table, there is some basis for rejecting some of the points.

[redacted]

DOE 6(3)

[redacted]

GROUP G-6 - B. Rossi, Group Leader

April 15, 1945

During the past month a new firing site was built in Bayo Canyon and a new section under group G-6 was formed for the operation of this site, with J. S. Allen in charge. The production facilities for chambers and preamplifiers were also enlarge With the new set-up it will be possible in the future to maintain a firing rate of one Ra La shot every five days, under the assumption, of course, of an adequate Ra La supp

(1) Results of Ra La Tests

Shot no. 16, April 1, 1945 (Ra La shipments no. 4 and no. 5 combined)

[redacted]

DOE b(3)

Source: Approximately 290 g Ra equivalent

All records were strongly disturbed by electromagnetic pick-up. The origin of this disturbance was traced to the fact that because of some changes in the experimental set-up, a direct metallic connection had been established between the ground system of the detection equipment and the detonated high explosive. A blank shot fire shortly after showed that the removal at this connection made the disturbances disappe It also revealed the existence of very large and rapidly varying differences of potential between the ground system and a conductor reaching into the high explosive flame. It may be added that even in absence of any disturbance, very little information could be expected from the present shot on account of the relative weakness of the source.

[redacted]

Shot no. 17, April 6, 1946 (Ra [redacted] shipments no. 4 and no. 5 combined)

[redacted]

Source: Approximately 630 g Ra equivalent

Magnetic detection: Magnet field: 185 gauss; pickup coil: 84 cm below center of charge. No shorting switch for the detonator condensers used.

Experimental Results

[redacted]

From the magnetic record it was possible to determine the beginning of the implosion, and to obtain the following additional information.

Acceleration time: 1.1 microsec.

Initial velocity outer Al surface: ~1700 m/s

[redacted]

Shot no. 18, April 15, 1945 (Ra La shipment no. 4 and no. 5 combined)

Source: Approximately 215 g Ra equivalent

Magnetic detection: magnetic field: 171 gauss;

pick-up coil: 64 cm below center of charge.

Experimental Results

[redacted]

No correction for time resolution yet computed.

From the magnetic record, in addition to the beginning of the implosion, the following information was obtained.

Acceleration time: 0.9 microsec.

Initial velocity outer Al surface: ~1500 m/s

(2) Improvements of the Experimental Method for Ra La Tests

A. Further tests have been carried out on the timing circuit for measuring the simultaneity of detonation.

[redacted]

B. Static absorption measurements on lenses were carried out. Also new measurements were taken on composite metal shells. A report is being prepared.

C. The air driven rotating shutter for the pulsed γ-ray source, designed by Serduke, has been assembled and given a preliminary test. A velocity of only 3800 r.p.s. could be obtained and some modifications are necessary before one can hope to approach the desired speed of 20,000 r.p.s.

D. Longer chambers have been designed and put into production in order to increase the sensitivity of the detecting equipment.

E. The time resolution of the detecting equipment was investigated more carefully by means of the pulsed x-ray source. For this investigation a fast monitor chamber was built.

(3) Geiger-Muller Counters

Production continued according to requests.

(4) Personnel

A. Ra La Detection Equipment in Bayo Firing Site No. 1

Rossi, Staub, Chromey, Levine

B. Magnetic Detection Equipment

Fairbank, Kiszenick, Mallinckrodt, Stone

C. Preparation of Shots (including H.E., Source Transfer Devices, Etc.)

Diven, Menz, Friedrick, Kissee, Jordan

D. Construction of Expendable Electronic Equipment

Harper, Hartig, Venghaus

E. Design and Construction of Electronic Equipment for Firing Site No. 2

Allen, Nereson, Everhart, Burditt, Kiszenick, LaBarge

McCaughey, Miller

F. Experiments on the Time Resolution

Staub, Dellenbaugh

G. Development, Construction and Testing of Ion Chambers

Nicodemus, Dellenbaugh, Powers, Volpe, Lustgarten, Haley, Hudson

Henderson, McLaughlin, Newbury

H. Static Absorption Measurements

Koontz, Hall

I. Evaluation of Data

Koontz, E. Staub

J. Timing Circuit

Jurney

M. Shop

Moloznik

N. Tests for Radiation Hazards

Miller, E. Staub

O. Secretary

H. Nyer

[redacted]

 [redacted]

GROUP G-7 - E. J. Hofgren, Group Leader

April 16, 1945

1. Field Service and Circuits

Bayo, Sandia, K Site, Pajarito, B Site, R Site, L Site are now being supplied with electric detonators and circuits. The detonators supplied are Cal Tech loaded 1-E 3's which must be fired at 7500 volts and not less than 1/4 mfd.

Bayo has fired 2 lens shots using 2 1-E 3's mounted side by side on a tetry train consisting of one 3/8" pellet surmounted by 2-7/8" pellets. The wave form of this kind of booster when detonated from only one side has been found satisfactory by Hoffman. [redacted] The chance of such failure is unknown as there never has been a single failure out of about 700 production detonato fired at 7500 volts and with 1/4 mfd. or greater capacity.

Further work on double adaptors for single detonators is under way.

Adaptations of the Raytheon circuit for field use are under test. When tested, they will provide a non-expendable device to replace the explosion switch and give severe field testing of Raytheon components. Their immediate use will be limite by the fact that production of detonators to fire at 5600 volts is about 150 per day

2. Gadget Detonators

G-7 has been asked to prepare to solder bridge wires and do the first loading operation on 300 per week of the 1773's[1]. We have further been asked to specify subsequent loading operations. This work is under way, but is hampered by slow

1) (Henderson's design of gadget detonator) [redacted]

[redacted]

[redacted]

procurement of mechanical parts. From the experience gained from the above work, G-7 and the C.I.T. experimental group will provide the C.I.T. production group with loading specifications.

We have also been asked to do preliminary durability tests on detonators so that we can recommend to X Division final tests to be carried out by them. The most tentative indications are that PETN bridge wire detonators will stand shaking and moisture but are damaged by temperature of about 80°C.

Silver bridge wire will be used in the 1773's on the basis of our experience with South Mesa loaded 1-E 3's.

However, there have been either unexplained failures or very late detonators at a rate of about one in four or five hundred. It is hoped that rigid controls will reduce the number of bad detonato

Because the voltage and capacity of the Raytheon set are marginal and becaus of the above indicated temperature deterioration of PETN detonators, work has been resumed on Lead Azide spark detonators. Preliminary results show that highly pressed Lead Azide has a mechanical sensitivity about the same as that of the re-crystallized PETN now in use. Other explosives will also be investigated in an effort to devise a safe and reliable detonator with as good or better timing than the PETN bridge wire.

3. Production and Control

Production is continuing at about the level of last month. The only change is that in every step we are instituting better controls and inspection. Mr. Knudsen is making physical inspection of bridge wires, length of explosive train, insulation, etc. Mr. Seely is standardizing explosive preparation and making extensive micrographic studies to define the nature of "good" PETN.

[redacted]

[redacted]

 [redacted]

GROUP G-3 - D. Froman, Group Leader

April 15, 1946

PERSONNEL: N. F. Benzon, J. C. Blair, B. Elmore, G. T. Felbeck, G. L. Felt, C. B. Fisk, D. K. Froman, A. C. Graves, W. Y. Gutcheon, R. C. Ludwig, D. G. Marshall, V. A. Nedzel, H. W. Newson, H. N. Pennypacker, J. H. Roberts, B. M. Van Lyssel, J. L. Waiter, J. J. Wechsler and J. W. Wood

5. Resistance Wire: (J. H. Roberts)

A method of observing the motion of a plate propelled by H.E. by observing the continuous change in resistance of a spiral resistance wire touching the moving plate has been developed. The method gives results of comparable precision and in good agreement with those obtained by the pin-contact method. Tests are in progress to determine whether or not two or more such resistance measurements can be made simultaneously.

10. Imploding Hemispheres: (A. C. Graves) DOE b(3)

There was no indication of a difference of starting time betwe these two points.

One shot with 12 L 60B 1st quality lenses and with a 2S 60-80-98 Baronal Comp. B liner.

[redacted] DOE b(3)

The calculation assumed no convergence in the steel. In this one, too, the [illegible] timing was shown to be good.

One shot like the preceding shot, except that the 1/4" steel liner was replaced by an 0.429" steel liner, was made. Pin settings were too close for the pulses to be well resolved. The record was too poor to permit any statement about timing and the probable error on the velocity given is considerable since it is based on drawing the best straight line through three points.

Two shots like the preceding shot, except that no liner was used, were made

Two shots, with the same pusher and liner used in the first two shots, were made.

It is not planned to shoot more such shots until first quality lens are available. A summary of the above data is given in the table below:

Considerations in the Theoretical Division indicate that, for velocities exceeding about 8000 m/sec., the pin-contact method measures the velocity of the air blast wave preceding the metal. Experimental tests on this point are in progress. If this is the case, the values given in the table above are 10 percent to 15 percent too high except, probably, for the tuballoy liner.

For aid in interpretation of the RaLa records, two types of flat plate shots were made. In the first the thicknesses of charge, aluminum and cadmium, were made the same as in the spheres mentioned above. In the second, tuballoy plates 6 mm thick were substituted for the cadmium. One point initiation was used and the velocity measured under that point. Two shots were made with cadmium and two with tuballoy. All the records were excellent. The two values for the velocity of the cadmium due to the first shock were 1320 and 1400 m/sec. respectively. The two values for the tuballoy were the same, 1270 m/sec.

13. Shock and Initial Velocities in Metals. (J. H. Roberts and V. A. Nedzel)

The following table summarizes the data on shock and initial velocities obtained to date using conical "Tuck" lenses tamped with spherical grained tetryl:

Metal	Shock Velocity in Km/sec.	Initial Vel. in Km/sec.
Aluminum	6.8	3.5
Cadmium	4.0	2.7
Lead	3.1	3.1
Steel	5.0	1.35
Tuballoy	3.3	1.15

The shock velocity values above represent averages of values obtained with all thicknesses of plates used since little variation of the shock velocity with thickness of plate was observed. However, it was found that the initial velocity of a given material varied in some cases considerably with the thickness of the plate. The values listed above were those observed for 1/8" thickness, or extrapolated to that thickness, except that for tuballoy which is the average for thicknesses rangin from about 1/8" to about 1/2".

The effect of plugs of beryllium in steel plates has been studied in both flat and hemispherical shots. The flat plates were 1/4" thick and had inserted in them cylindrical plugs 1/2" in diameter and truncated conical plugs 1/2" in diameter at the base and 1/8" diameter at the top. Two shots were made with the apex of the

The velocities obtained are:

Arrangement	Under booster pt. in km/sec.	Under interaction point in km/sec.
a.	.85	1.25 initially which changes abruptly at 6 mm. from the plate to 1.6
b.	.9	1.3 initially which changes abruptly at 6 mm. from the plate to 2.1
c.	1.0	1.4 to 2.0
d.	1.15	1.3 initially which changes abruptly at 6 mm. from the plate to approximately 2.4

Thus it would appear that as the Baronal is shifted upwards in the charge, the velocity under the booster points increases. The initial velocity of the jet appears constant but the velocity after the jet moves 6 mm. is subject to wide fluctuations. There is no evidence that shifting the position of Baronal relative to Comp. B can eliminate jets.

17. Velocities Useful to the Initiator Program. (H. W. Newson)

The following table gives velocities obtained in measurements of various initiator arrangements.

The last two arrangements were each measured three times. Fairly consistent velocities were found after the steel had moved 1.5 mm; the measurements continued up to a displacement of 5 mm.

The velocities in the first 1.5 mm. are much less than those later on. The possibility that a sound wave in the steel is causing this effect seems unlikely.

cone pointed toward the explosive and one in the opposite direction. A steel plate 1/2" thick was placed between the explosive and the plugged plate. In all three cases the velocity of the beryllium was found to be 2.2 km/sec. and the velocity of the steel was 1.4 km/sec. The latter value is in good agreement with previous measurements of the material velocity of steel under these conditions. It was also observed that the cone with apex toward the explosive started moving 0.2 microsec. before the steel, the cylindrical plug moved 0.4 microsec. before the steel, and the cone with apex away from the explosive moved 0.8 microsec. before the steel. In other words, at the time the steel begins to move the three plugs will have advanced 0.44, 0.88, and 1.32 mm respectively. The explosive in these shots was a pentolite cylinder 3-1/2" diameter x 6" high which was detonated by a Tuck lens.

[redacted]

A cylindrical beryllium plug led the steel by nearly a micro-second and had a velocity of 8 km/sec. A conical plug with apex toward the explosive led the steel by a lesser amount, but the record is insufficient to give an estimate of its velocity. The results of this paragraph are tentative pending confirmation.

18. Propagation of the Converging Shock Wave in the Solid Gadget. (D. J. Marshall)

Pins are put into holes drilled into scale models of a solid gadget in order to record the arrival of the shock wave at different radii.

[redacted]

There is some

[redacted]

[redacted]

GROUP [illegible] - C. L. Critchfield, Group Leader

April 16, 1945

DOE b(3)

1. Initiators

Furthermore, some theoretical results of Fuchs indicate that a gun type initiator, in certain essential respects different from designs proposed previously, may be worth further consideration. Major programs on these new proposals have not been set up within the group, however, because of the press of programs already under way.

Enough work has been finished to enable us to form a tentative opinion of the relative merits of the several techniques in proof. There is considerable uncertainty in the interpretation of active shots made under recovery implosion conditions.

There are definite indications that the efficiency decreases as the amount of shielding metal is increased.

[redacted]

The combination of the aberration in the tetryl-tamped "Tuck" lens and the non-uniformity of Pentolite cast cylinders gives rise to considerable divergence in the detonation wave at the end of the cylindrical charge. The wave can be made more nearly plane by substituting spherical grained INT for the tetryl and further measurements will be made using lenses tamped with INT.

14. Velocity of Plates, Radius Effect and Jets. Effects of Baronal Pads. (J.C. Dial

The effect of baronal pads on the velocities under booster and interaction points has been observed by the straight contact method using flat metal plates. Four different configurations of charge were used:

a. 1" Pentolite on top of 1-1/2" Baronal.

b. 1" Comp. B on top of 1-1/2" Baronal.

c. 1-1/2" Baronal sandwiches between two layers of 1/2" Comp. B.

d. 1-1/2" Baronal on top of 1" Comp. B. 1/4" of Comp. C was placed under the tetryl booster to insure detonation on the Baronal face.

The booster points were fired simultaneously with branched primacord and the points were placed 4" apart. Thus the angle between the line from the booster point and the normal to the lower H.E. surface through the interaction point was preserved at 38°.

A steel plate 1/4" thick was placed below the charge and three groups of pins were clustered under the metal; two groups under the booster points and one under the interaction point, midway between the boosters. The existence of a jet could be established by the increase of material velocity under the interaction point over that observed under the booster points.

[redacted]

The latter figure is considerably lower than that for the corresponding arrangement of shells.

The same general conclusions, indifference to nature of shielding material and decrease of efficiency with increased quantity of shielding material, are drawn from about thirty hot shots made with the 20 mm gun. [redacted] This is remarkably high considering the many opportunities for Po to be trapped in ineffective pockets. In fact, the efficiency thus obtained is comparable to that of the standard capsule type gun initiator in which the possibilities of trapping are presumably minimized. This high efficiency, plus evidence in both the gun shots and implosions that the more severe shocks lead to higher efficiency, suggests strongly that the efficiencies produced may be only partly due to primary action of the design and partly due to some secondary, thermal effects, the time scale of which may be too long to be of value for initiating purposes. [redacted] the primary action could be assumed to be the same in both types of loading (a doubtful thing to do), the secondary effects account for more than three-fourths of the total activity in the gun shot. [redacted]

The possibility of secondary effects that take place in times long compared with the critical time is the chief source of uncertainty in the interpretation of hot shots. If these effects cannot be understood and evaluated, we have to rely entirely on demonstrating the primary mechanism of an initiator and calculating its

momentary efficiency. It is well established that temperatures 800°C and up[illegible] are produced in the test conditions for sufficient lengths of time to melt [illegible], form alloys of metals and the like. A more quantitative evaluation of the tem[illegible] which is presumably the residual temperature after return to zero pressure, is [illegible] attempted.

pected. Sherr has eliminated any possible effect of alloying, however, by using D. BeO in place of Be, and the efficiencies are practically the same. This elimin[illegible] the effect as a major part of the secondary activity except insofar as BeO and Be ma[illegible] be widely different in some other effect. The diffusion of Po through shielding material has been suspected and is being tested in controlled geometry by Vier of Johns' group. Finally, the motion of Po through cracks by surface diffusion or evaporation may be of importance. This will be tested in implosions by using range thicknesses of Be and also disposing the Be and Po so that migration has to take pla[illegible] in order to give activity. Preparations are being made to open active shots and determine the location of Po, and Johns is attempting to form metallic polonide for use in place of Po. The polonids should be much less migratory than the plated Po layers.

The time scale of secondary effects is most probably longer than the time scale of implosion compression. If the thermal effects arise from Po spreading over distances comparable to the dimensions of the initiator, i.e. one centimeter, the growth of secondary activity should require several milliseconds. If, on the other hand the Po migrates only very small distances, comparable to foil thicknesses of .0[illegible] mm., the time required may be of the order of tenth milliseconds. In either case there is reasonable hope of actually following the activity of the initiators as a function of time by surrounding gun targets with a paraffin block containing BF_3

counters. The relaxation time of such a system can be reduced to a few tenths a millisecond. The setting up of such a counting system and protecting it against the blast of the gun has been achieved in fine fashion by V. C. Wilson and his [illegible] and the first hot shot has been fired. Low activities are being used at first (30 mc Po), and the first record indicates no significant growth in intervals of tens of milliseconds after activation of the initiator which, in this round, happens to be a nicodemus. The counting system itself is about 20 percent efficient and may be pushed to 50. These efficiencies are made possible by using the enriched boron. Results by this counting method will probably be our most valuable information on secondary activity, and all initiator mechanisms that can be operated under gun impact will be tried by this method.

It is evident from the foregoing that a direct measure of the efficiency of an initiator is a difficult task even under the relatively low shocks produced in recovery implosions and gun impact. To supplement evidence obtained in that way, therefore, the proof program on initiators relies to an important degree on theory and experimental corroboration of theory and on demonstration of the primary mechanisms under the high pressure shocks.

D. P. McMillan, also of Parratt's group, is making X-ray studies of the melon seed and grapenut mechanisms, and some very good preliminary pictures of these have been obtained. All these studies are at relatively low shock and the

[redacted]

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results are to be extrapolated by theoretical considerations now nearing compl[illegible] by Fuchs.

Proof of the melon seed mechanism in cylinders by flash photo has been [illegible]pleted by Koski, as reported last month. The velocities in these experiments o[illegible] range extending up to 2 km/sec.

Certain observations relevant to the behavior of the primary mechanism [illegible] initiators will be made under very high shock strength. This is done by scalin[illegible] initiator design up to an observable size and shooting a hemispherical model in [illegible] a lens charge. The reduction in velocity expected from using only a hemisphere [illegible] from the large size of the initiator can be largely compensated by using only l[illegible] metals.

[redacted] Fulbrig[illegible] is setting up for measuring alpha activities contained in initiator mechanisms being imploded by half lens systems along the lines of an experiment proposed by Alvarez. This method, which will follow alpha activity as a function of time, can be used to detect trapping of surface Po upon acceleration, to determine the activity in jets, and possibly for other experiments. Lastly, in some cases, information as to the operation of the initiator may be gained from a study of fragments from lens shots, particularly if high melting metals are used and this will be investigated.

2. Recovery

DOE 1/2/

[redacted] It has been found that, although gross recovery is not sensitive to the amount of explosive provided that amount is large enough, the internal conditions are fairly sensitive. Thus the size of initiator ca[illegible] must be adjusted carefully to avoid cavitation.

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Velocities of impact inside the initiator cavity have been determined f
the recoveries used. This has been done by Hewson by placing pins at the pole o
the hemispheres.

Sampson has extended the realm of complete recovery of steel screwballs.

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GROUP G-11 - J. E. Mack, Group Leader

April 16, 1945

1. Services

A. Photographic service - Thompson, service manager

The darkroom load has increased appreciably, especially with regard to motion picture service (staff of 4).

B. Optics procurement and stock - M. Caldes, manager

The increased load of Mrs. Caldes has required that she be given help (staff of 1-1/2).

2. Kingman Test and Related Instrumentation - Brixner

The development of a continuous motion-picture camera for gamma ray detectio has been completed and production of 25 of these are now under way in the shop. Shop work is being handled by X Division (Waldman).

Camera (16 mm motion picture) and suggested method of installation were also supplied for photography of oscilloscope on no. 718 altimeter (de Hoffman).

A mil reticule scale was designed and constructed for the 16 mm camera on the parabola of the no. 584 radar (Polich).

There is no pending work on hand for Kingman.

3. Trinity Test Instrumentation - Mack

Most of the group's effort is now devoted to this test. We expect to be ready for the 100 ton experiment. The LAMS detailed progress report predicted last month has not yet been issued. Instrumentation beyond that list in LAMS-165 is:

16. Marley Motion Picture Camera for early stages (erroneously list[illegible] on 17 in March [illegible])
18. Photocell Drum Camera for time dependence
17. Black-body Receiver for total radiation
18. Moving-film Slit Camera for gamma radiation (pending complete d[illegible]n)
19. Schlieren study of shock wave (bottom priority)

4. Sweeping-Image Cameras - Brixner, Messenger

The revision and redesign of the rotating mirror camera drawings is co[illegible] for the base and the 8-1/2" and 18" superstructures. Revision of the 2" superst[illegible] is still to be made but this is on low priority. Additional revisions for adapt[illegible] new lenses to these cameras, is still going on, but at low priority. The purpo[illegible] this is to improve the efficiency of the optical system.

Two of the redesigned cameras have been completed by the shop and one h[illegible] been put in use at Anchor R. It is reported to be working very well. Three additional cameras are being made by the shop, on low priority.

The hexagonal prism mirror has been delayed in the shop due to Trinity work, and it is anticipated that these mirrors will not be completed till the latter part of May.

8. Stereo-devices

A measurement method developed for Koski's bi-mirror stereocameras has been submitted to Koski and used successfully by him.

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